

Vol. XXI, No. 2

MARCH 1954

THE SCIENCE TEACHER

1954 Annual National Convention

CHICAGO • APRIL 1-3

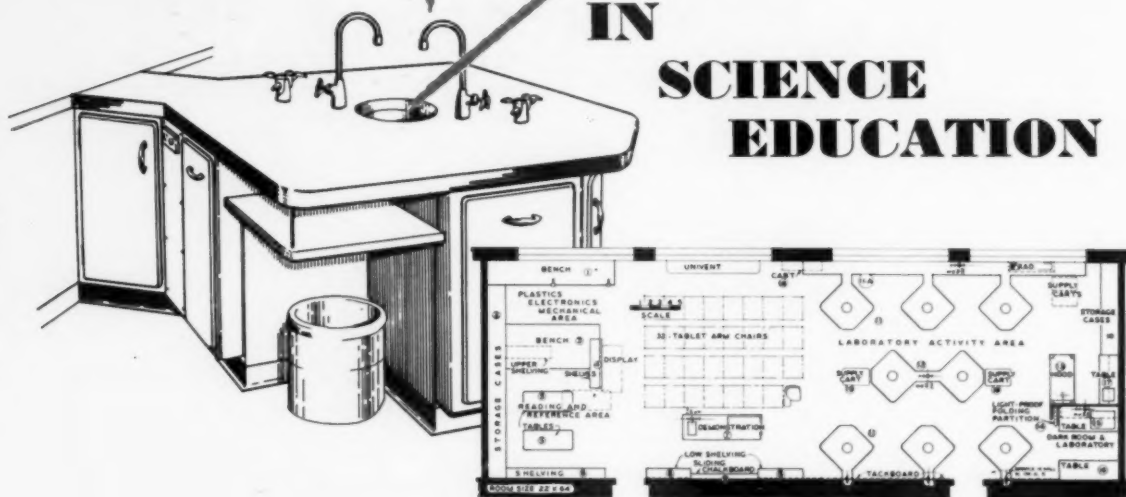


- Color TV—A Summary for Science Teachers
- Science Assembly for Elementary Schools
- Hydroponics for Students
- Chicago Convention Highlights
- Nominees for Officers and Directors, 1954-1955

JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION

Exciting News

IN SCIENCE EDUCATION



For the past several years there have been increasing rumbles of a new direction in science teaching, which will open new vistas for a properly-trained teacher in a properly-planned room.

Sheldon has been keenly aware of this new trend. We have watched it in successful practice and thoroughly explored the program with expert proponents. In consultation with leading teachers and administrators, we have carried out our own research program aimed at a clear analysis of new needs in both furniture design and room planning.

The result is a thorough grasp of essentials which we can express in fundamental simplicity — basic furniture units and a basic room plan. Out of the elements of this basic room plan we are prepared to fill any requirements you have in new total-experience science rooms — or to increase the effectiveness of your present setup. We invite your questions.

Send for the new Sheldon brochure entitled: "Sheldon and the New Direction in Science Education" — for teachers, administrators and architects. It will inform about this important new development.

E. H. SHELDON EQUIPMENT CO.
MUSKEGON • MICHIGAN

Sheldon FURNITURE

**Educationally-Correct for
HIGH-SCHOOL SCIENCE ROOMS, SHOPS, ARTS-AND-CRAFTS STUDIOS AND HOMEMAKING ROOMS**

Please mention **THE SCIENCE TEACHER** when you write.

YOU can select your teaching microscope AO OFFERS TWO!

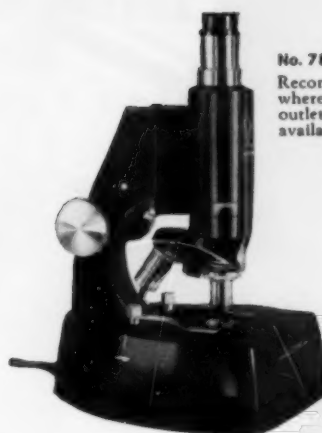


No. 66
Recommended
where electrical
outlets are NOT
available.

Convenient styling and standard design make up the No. 66 Student Microscope. All the performance features of more advanced microscopes are built into the No. 66 including:

- A fine adjustment with full 9-turn excursion.
- Durable all metal parts.
- Quality optics with a wide range of magnifications.
- Controls above stage, close to slide.
- Inclination joint for tilting to a comfortable angle.
- Substage mirror for utilization of any light source.

While initial cost is slightly higher than lowest cost microscopes, over a period of years the sturdy long-wearing No. 66 will actually save you money through low maintenance costs. Invest in the future with a No. 66. Write for detailed information.



No. 78
Recommended
where electrical
outlets are
available.

Modern in appearance and mechanically streamlined for efficient student operation, the No. 78 Scholar's Microscope is unprecedented for effective teaching. It has:

- Simplified adjustments to reduce instruction time.
- Low over-all height for comfortable posture.
- Reversed arm for clear view of stage, slides, objectives.
- Prefocused, built-in illuminator.
- Locked-in optics to prevent loss or damage.
- Safety stop to eliminate slide breakage.
- Quality optics for sharp clear images.

These are just a few of the No. 78's features that have revolutionized science teaching. For more complete information return the coupon below.



MAIL COUPON

today!

American Optical

Dept. C95



INSTRUMENT DIVISION
BUFFALO 15, NEW YORK

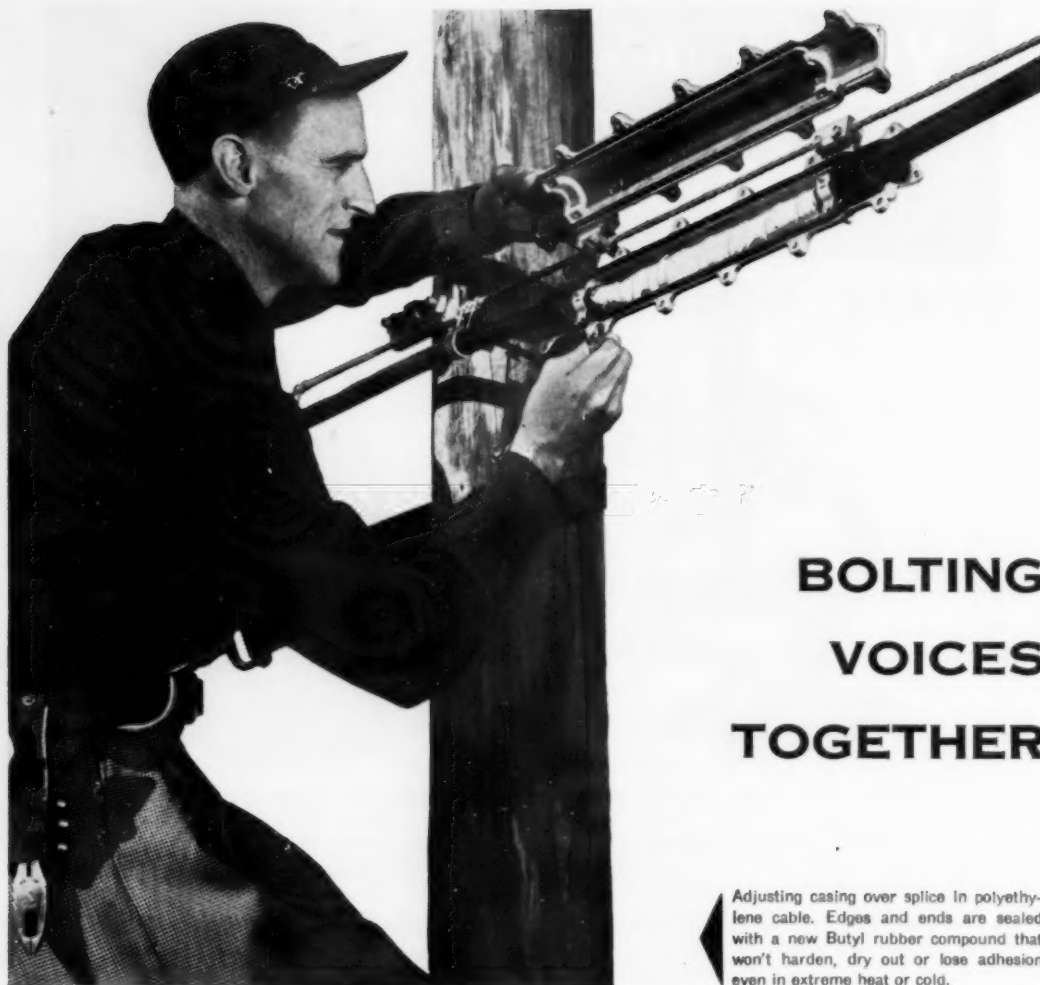
Please send me free literature on:

- ☐ AO No. 78 Microscope
☐ AO No. 66 Microscope

Signed

Address

Please mention THE SCIENCE TEACHER when you write.



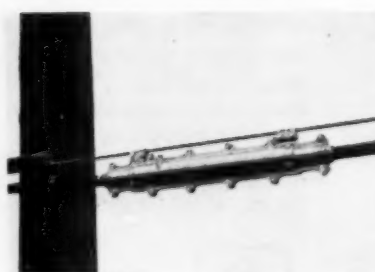
BOLTING VOICES TOGETHER

Adjusting casing over splice in polyethylene cable. Edges and ends are sealed with a new Butyl rubber compound that won't harden, dry out or lose adhesion even in extreme heat or cold.

More than ever, light, flexible polyethylene sheathed cable developed by Bell Telephone Laboratories is providing speedy answers to the demand for more telephone service.

But at thousands of splices, the sheath must be thoroughly sealed against moisture. Laboratories engineers developed a protective casing which is quickly and simply bolted in place. The edges and ends of the casing are *permanently* sealed with a new compound developed by Laboratories rubber chemists.

Now, economical polyethylene cable can be installed much faster and at lower cost. Here is another example of how Bell Laboratories continually finds ways to keep telephone service high in quality, while the cost stays low.



CLOSED CASING IN PLACE

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.



a HEATH text is your BEST text . . .

ADVENTURES with Animals and Plants

A GENERAL BIOLOGY

by Kroeber and Wolff

TEACHERS—
this book provides you with:

A complete program adaptable to any high school course in biology.

Flexible and sound organization—text divided into ten units with each unit in the form of a general statement—two to five problems in the form of a question for each unit—forty-one problems in all, with some problems marked “optional”.

A list of review questions included at the end of each problem and arranged in order of subject matter presentation.

Use of inductive teaching method, with a wealth of examples.

Easy-to-read style with a minimum of scientific terminology—new terms italicized—phonetic pronunciation used for new and difficult words.

A list of suggested individual and class activities with a further activities list for the more advanced students.

Numerous well-chosen illustrations that are a definite complement to the text.

A classified list of books, films, pictures, and pamphlets at the back of the book.

*Write to the nearest
HEATH OFFICE for more
information about
Heath Science texts.*



D.C. HEATH
and Company

SALES OFFICES: NEW YORK CHICAGO SAN FRANCISCO ATLANTA DALLAS
HOME OFFICE: BOSTON

Please mention THE SCIENCE TEACHER when you write.



THIS MONTH'S COVER . . . portrays a view of the Chicago skyline as seen looking west and north across Grant Park. The implication, of course, is that this and many other attractions will greet your eyes when you attend the second national convention of NSTA in Chicago, April 1-3. Convention highlights and pictures of many of the participants will be found on pages 76-78. Kaufmann & Fabry Photo.

Readers' Column

RE-TIRED OR RE-CAPPED?

In the mechanical world retiring is a replacement. The old are removed and others, usually new, take their places. Those removed commonly go to the junk pile; are rarely reused. Recapping is something else. The operator scans the wheels and returns with the decision, "There's still service in those old casings. Recapping'll make them good for another ten thousand miles."

As the writer, year after year, reads the report of his teacher friends stepping aside, i. e. retiring, so that replacements may take up their duties, he has often wondered if "recapping" might not have been a more creditable and efficient program for all concerned. He often experiences an up-surge of impatience as he hears the lament, becoming increasingly vocal, about science teacher shortage and manpower shortage for the technological expansion with its inescapable insistence that only scientifically trained need apply. In a mood of pessimism he sometimes thinks, inaudibly, "We junk the experienced at one end and mushroom the novices by reduced training programs at the other." To add further chaos to confusion the potential engineer or scientist is pulled out of the program for his share of army service. Isn't it about time that our "operators"

stand aside to see if some of the "old casings" can't be "recapped for another ten thousand"?

No doubt there are many of the three-score-five's who, in the language of the wife of one of them, "find freedom from the classroom a great relief." On the other hand there are surely many "refugees from the rolls of those with marketable services" who will join the writer in saying, "I never, even at the last, considered mutiny to my classroom."

In 1952 (according to *Federal Fact Book on Aging*) only fourteen per cent of the thirteen million men and women aged 65 or over were unable to work. Whether the per cent of teachers in that group would be more or less is not stated. Certainly if provision were made for part time service there is a very sizeable reservoir of teacher-reserves from which to draw.

This writer is not under any delusion that what is here said will make any difference with his status. He is optimistic enough, however, to believe that the next generation may do something about it if they will tackle the problem in the same objective fashion they use in serving the young people who come to their classrooms.

To illustrate: When a high school student applies for admission for college registration he is subjected to a rather thorough inventory. That provides for an assessment of each individual's interests, preparation, and abilities in relation to the program which he proposes to follow. If his English is faulty, he is advised to defer his foreign language; if his mathematics has tripped him, he may be required to detour a course in physics. In other words his acceptance for placement in the college population is conditioned by both his skills and his deficiencies. What those bases of assignment were was not decided upon by a behind-doors dean-adviser conference with the student on the outside. That information came through objective tests scored and tabulated by machines. Chronological age was not a determining consideration in the approved program.

In contrast with the above plan for entering a college, what is the procedure by which one of its teachers is "promoted" from its service? The first consideration is, "How old, chronologically, have you become?" Next, what does your dean, department chairman, and maybe the chairman of the committee on retirement think should be done for you? You who are most concerned are "not in" on any of this.

A freshman's protest over adviser placement would be answered, "All this that the college may render its maximum service." If asked to do so, that adviser would produce factual itemized test ratings as justification for what the student might consider irregularities in his assignment. What would result if a re-assigned faculty member were to ask for an autopsy? The first response, no doubt, would be, "You know there is a rule set up by our college trustees?" If that doesn't satisfy, "You are X years old, are you not?" If the "professor" is one of that semi-incorrigible sort

(Please continue on page 104)

THE SCIENCE TEACHER

The Journal of the National Science Teachers Association, published by the Association, 1201 Sixteenth Street, N. W., Washington 6, D. C. Membership dues, including publications and services, \$4 regular; \$6 sustaining; \$2 student (of each, \$1.50 is for Journal subscription). Single copies, 50¢. Published in February, March, April, September, October, and November. Editorial and Executive Offices, 1201 Sixteenth Street, N. W., Washington 6, D. C. Copyright, 1954, by the National Science Teachers Association. Entered as second-class matter at the Post Office at Washington, D. C., under the Act of March 3, 1879. Acceptance for mailing at Special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d), Section 34.40 P. L. & R. of 1948.

OFFICERS OF THE ASSOCIATION

Charlotte L. Grant, *President*, Oak Park and River Forest High School, Oak Park, Illinois
Harold E. Wise, *Retiring President*, University of Nebraska, Lincoln 8, Nebraska
Walter S. Lapp, *President-Elect*, Overbrook High School, Philadelphia, Pennsylvania
Zachariah Subarsky, *Secretary*, Bronx High School of Science, New York 53, New York
John S. Richardson, *Treasurer*, Ohio State University, Columbus, Ohio
Robert H. Carleton, *Executive Secretary*, 1201 Sixteenth Street, N. W., Washington 6, D. C.

MEMBERSHIP

The membership year coincides with the calendar year. New entries during the fall months extend through the following calendar year. Library and elementary school subscriptions coincide with the school year or run for one year from date of entry.

Active Membership	\$4.00
Sustaining Membership	\$6.00
Student Membership	\$2.00
Library Subscription	\$5.00
Elementary School Subscription*	\$5.00
Life Membership	\$100.00
(payable in annual installments of \$10.00)	

* Includes the *Elementary School Science Bulletin* in quantity lots.

Coming . . .

in the April issue of *The Science Teacher*

- A Laboratory Activity in Astronomy
- Student Evaluation of Teaching in Biology
- Symposium—"The First Week of School in Science"
- Elementary Science Cooperative Activities

Editor's Column

A great temptation arose when Dick Lape sent me all "the dope" on the nominees chosen by his committee for vacancies among officers and directors for 1954-55. The training, experiences, competencies, and range of services displayed by these teachers makes one proud to be associated as a colleague. My temptation was to try to write a story that might help refute the distorted tirades that have been offered as commentaries on teachers and the schools, such as those appearing recently in *The American Magazine* and *Colliers*. On second thought, however, I decided that I could better serve NSTA and education in general by turning my time and energy to other matters and by giving these articles the treatment they merit—passing attention as amusing reading soon to be forgotten. I can't help but wish, however, that these self-appointed, expert critics of the schools (who often admit that they haven't been in or close to a high school for x years) would take even a week out of their busy programs and live the life of a teacher in a modern high school that is attempting to provide the maximum in *functional* education for *all* the children of *all* the people!

— o —

This matter of membership promotion and retention is one of taking three steps forward and two backward—not only in NSTA but in other comparable groups, I find. This is the time of year when NSTA's Governing Rules, established by the Board of Directors, require us to drop from our mailing roll members who have not renewed by payment of dues for 1954 (the membership year is the calendar year). If past history repeats, we will have to drop about 900 names. Meanwhile, through the efforts of our national membership chairman and his committee and some two hundred state and area directors we will have added perhaps 1500 *new* members to our roster. The drop-outs are difficult to explain. Certainly it is not for lack of tangible services; certainly it is not for lack of a dynamic policy and program for the advancement of science teaching. Perhaps it is because we science teachers are still learning that "in unity there is strength" and that all of us owe some little obligation to support and help advance the profession in which we are engaged. Perhaps we need to be reminded of this from time to time. Will you help "the cause," perhaps by reviewing NSTA Activities and FSA Activities in a few recent issues of *The Science Teacher*, and then carrying the story to your colleagues and friends in science teaching?

— o —

In case anyone needs reminding—send your advance registrations for the Chicago convention to the *NSTA office*; send your hotel reservation requests directly to the Morrison Hotel in Chicago. As of this writing, we have received nearly 100 advance reservation forms. This puts us well ahead of the response for Pittsburgh last year. This fact, plus other "straws in the wind," indicate a convention attendance of around 1000 persons!

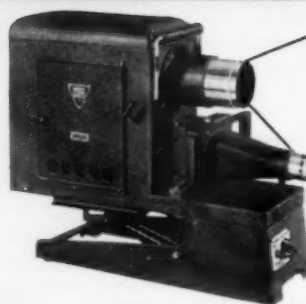
Robert H. Carleton

For EASIER, FASTER TEACHING . . . BETTER UNDERSTANDING

In today's overcrowded science classes these three low-cost visual aids give *every* student the full advantage of your instruction. Exclusive Bausch & Lomb features provide today's brightest, most detailed images...offer the widest range of practical use. Use them to help your students learn better . . . by helping them *see* better.

B&L MODEL LRM BALOPTICON PROJECTOR

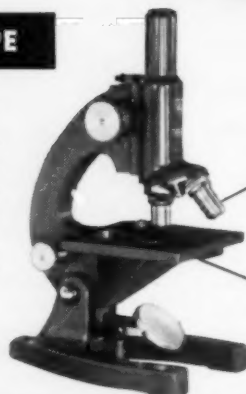
Unequalled versatility. Projects large, clearly detailed images of slides *and* opaque objects, specimens, printed matter, photographs . . . your imagination sets its only limits! Catalog E-11.



Projects:
OPAQUE OBJECTS
SLIDES • BOOKS
SPECIMENS • CHARTS
PRINTED MATERIAL
PICTURES

B&L "FL" MICROSCOPE

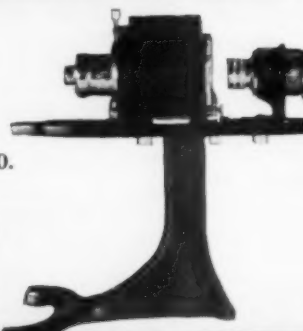
Full standard size throughout! Pre-focusing gage, saves time. Superb resolution, flat fields, with achromatically corrected 10X and 43X objectives. More teaching advantages than any other student microscope, at any price. Catalog D-185.



SEPARATE
COARSE AND FINE
FOCUSING
•
INTERCHANGEABLE
ILLUMINATOR AND
MIRROR

B&L TRIPLE-PURPOSE MICRO-PROJECTOR

Projects permanently mounted specimens, or live specimens in liquid—on screen, for class viewing, or directly on sketch pad for drawing or tracing. Catalog E-10.



Projects:
MOUNTED SPECIMENS
IMAGES for TRACING
LIVE SPECIMENS

WRITE for demonstration and literature. Bausch & Lomb Optical Co., 78027 St. Paul St., Rochester 2, N. Y.



Bausch & Lomb

Educational Instruments

THE SCIENCE TEACHER

Vol. XXI, No. 2

March, 1954

Staff

ROBERT H. CARLETON Editor
MARY E. BATISTE Assistant
FRANCES ANN KEEFAUVER Subscriptions

Advisory Board

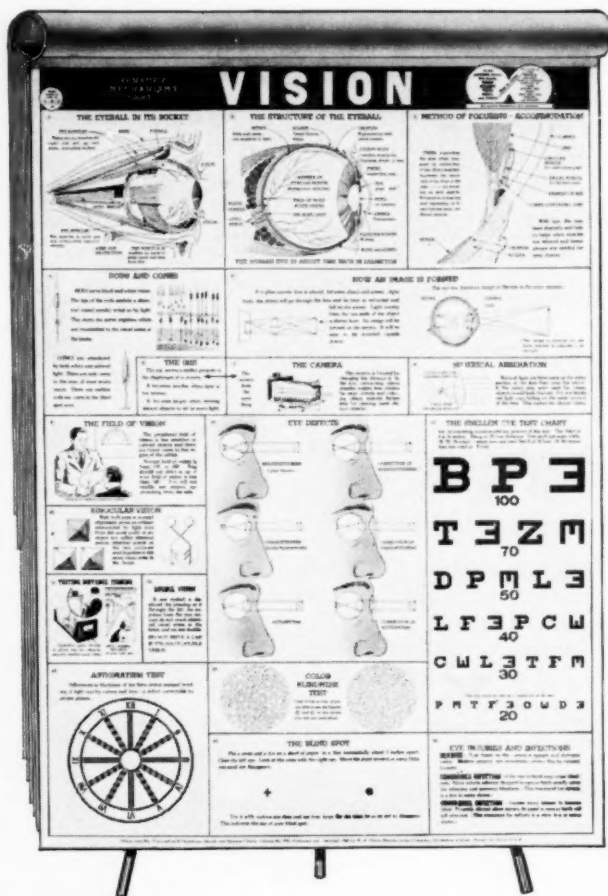
MISS ARCHIE J. MAC LEAN, (1955),
CHAIRMAN
PAUL BLACKWOOD (1956)
MARJORIE CAMPBELL (1954)
CHARLOTTE L. GRANT (1954)
LOUIS PANUSH (1955)
FLETCHER WATSON (1956)

Articles published in THE SCIENCE TEACHER are the expressions of the writers. They are not a statement of policy of the Association or the Magazine Advisory Board.

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Color Television—A Survey for Science Teachers <i>Robert Stollberg</i>	57
Reading and Plugging In—Through Elementary Science <i>R. Will Burnett</i>	65
What Should High School Science Do? <i>Donald W. Stotler</i>	68
Implications for Teacher Education in Science <i>Kenneth E. Anderson</i>	71
Hydroponics <i>Paul A. Chatelier</i>	74
Highlights of the NSTA 1954 National Convention	76
What Holds the Water Up? <i>M. F. Vessel</i>	79
The School Assembly as a Science Experience <i>Marjorie Bingham and N. Eldred Bingham</i>	81
Trends in Science Education—1953 <i>Stanley B. Brown</i>	84
Nominees for Officers & Directors for 1954-55	86
Classroom Ideas	
How to Make a Carbon Microphone Using a Telephone Speaker <i>Charles F. Beck</i>	95
An Electro-Mechanical Television Analogy <i>Harry Milgrom</i>	93
Thermostat Demonstrator <i>Jennings King</i>	93
NSTA Activities	89
FSA Activities	91
Book Reviews	102
Clip'n Mail	104
Our Advertisers	104

An Indispensable Teaching Aid for **PHYSIOLOGY, HEALTH, HYGIENE, SAFETY and FIRST AID** 30 CHARTS - Over 600 Illustrations in Color



No. 17—Vision of set No. 7050

Large size—29 x 42 inches, yet convenient to handle.

No. 7050. **PHYSIOLOGY CHARTS**, set of 30, in colors, in a metal charthead on portable tripod, with manual... \$37.50

Charts 1 to 21

are edited by

Dr. A. J. Carlson, Emeritus Professor of Physiology, University of Chicago.

Charts 22 to 30

by eminent specialists in the fields of health, hygiene, safety and first-aid

Original method of presentation with interest as primary motive.

Not Technical—body functions and proper body care is underlying theme.

Self-teaching—brief explanations on each chart explain drawings without need of reference to texts.

Color differentiation clarifies body processes as well as emphasizing most important facts.

TITLES OF THE 30 CHARTS

THE CELL, 28 illustrations.
CHEMISTRY IN PHYSIOLOGY, 20 illustrations.
PHYSICAL CHEMISTRY IN PHYSIOLOGY, 22 illustrations.
CELL FUNCTIONS, 24 illustrations.
BLOOD, 15 illustrations.
RED BLOOD CORPUSCLES, 27 illustrations.
WHITE BLOOD CELLS, 16 illustrations.
CIRCULATION OF BLOOD, 8 illustrations.
WORK OF THE HEART, 11 illustrations.
BLOOD FLOW AND PRESSURE, 20 illustrations.
RESPIRATION, 21 illustrations.
SOME BREATHING ACTIONS, 16 illustrations.
THE ALIMENTARY CANAL, 9 illustrations.
THE STORY OF FOODS IN THE BODY, 26 illustrations.
THE ACTION OF MUSCLE AND NERVE, 11 illustrations.
MECHANISMS OF CORRELATION, 13 illustrations.
VISION, 25 illustrations.
SENSORY MECHANISMS. Part II, 25 illustrations.
GLANDS OF INTERNAL SECRETION, 12 illustrations.
REPRODUCTION AND EARLY DEVELOPMENT, 23 illustrations.
BODY DEFENSE AGAINST DISEASE, 30 illustrations.
HEALTHFUL LIVING, 48 illustrations.
FOODS AND DIET, 21 illustrations.
BACTERIA AND PARASITES, 26 illustrations.
MAJOR MALADIES, 20 illustrations.
COMMUNITY HEALTH, 35 illustrations.
DRUGS AND MEDICINES, 29 illustrations.
ALCOHOL AND TOBACCO, 24 illustrations.
LIVING SAFELY, 47 illustrations.
FIRST AID, 37 illustrations.

TEACHERS' MANUAL furnished with set contains 128 pages of factual material, including 80 experiments.

Write for circular.

W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

ESTABLISHED 1880

1515 SEDGWICK STREET, DEPT. T

CHICAGO 10, ILLINOIS, U.S.A.

COLOR TELEVISION

a survey for science teachers

By ROBERT STOLLBERG

This article is intended to help science teachers keep abreast of some of the latest developments in color television, as well as conventional black-and-white television. It is specifically written for teachers without thorough technical backgrounds. No electronics circuits are on these pages, and no mathematics beyond elementary arithmetic is involved. The writer attempts to answer some of the how's and why's of television, particularly those which are apt to come up in science classes. In the closing paragraphs he takes a hesitant peek into the possible future of this fascinating, new development in the science of communication.

Color television involves the application of several fields of science and mathematics. Electricity and electronics are represented, of course, as are the physical characteristics of light and color. The physiology of the human eye, particularly in relation to flicker, and color perception are also involved. Mathematics, from simple arithmetic to the most complex and abstract concepts, abounds. Among the less technical fields, literature, the arts, psychology, and human relationships are involved in this medium of communication. Because of this wide diversification of subject-matter in color TV, it is sure to be a frequent as well as valuable topic in public schools, particularly in science classes.

The author, Dr. Robert Stollberg, is Associate Professor of Science and Education at San Francisco State College, California. He is a member of the NSTA Board of Directors. His "pedigree" is given on page 86, where he is offered as a candidate for President-Elect of the Association for 1954-55.

HIGH school boys and girls have a reliable habit of keeping up with spectacular achievements in science. Typical science teachers will testify—perhaps wearily—that their students are intensely interested—and sometimes surprisingly well-informed—about such developments as space travel, "miracle drugs", and nuclear-powered submarines. A few teachers even deplore such curiosity as a serious nuisance—it keeps them "off the subject"!

Unfortunately, many teachers are embarrassed by their lack of knowledge along the lines of these recent advances. This feeling should not degenerate into a guilt complex, however. No one—not even the science teacher!—should be expected to know everything. If real mastery of subject-matter were the characteristic of a good instructor, none of us could even approach the mark. A better criterion of quality is one's willingness to admit his lack of information, and his interest and ability in finding what he wants to know.

In view of the recent official approval and actual transmission of color television, it appears that many

student inquiries will be aimed in this direction for some time to come. Here, all but the most unusually prepared science teacher will find himself far beyond his depth. Most of us will be painfully reminded that we know precious little about black-and-white TV, to say nothing of the latest advances in the field of color.

If the teacher is commendably energetic and seeks the information which he and his students need, he is thwarted at nearly every turn. Technical information in TV is complicated. Most articles written by competent television engineers assume a background in electronics and mathematics far beyond that of the typical high school teacher. On the other hand, the readable, popularized articles on color TV are often too superficial to provide answers to typical "how and why" questions. Unfortunately, some of the writers of semi-technical materials are themselves technically uninformed. As a result, their comments may deviate from the facts. Needless to say, high school science texts are silent on the latest developments in this field.

What America's science teachers need is a good "non-technical treatment of the technical aspects of color television!"

It is not surprising to find that even a modest understanding of color TV requires more than a nodding acquaintance with black-and-white television—more than most of us have. With this in mind, this inquiry into color television begins with a summary of certain pertinent aspects of conventional television.

The Formation of a Television Picture (1)

Most TV viewers know that the picture on their screen is made up of many horizontal lines. What they often do not realize is that each *line* is traced out by a moving *spot* of light. Each complete picture is made up of 525 horizontal lines—and there are 30 complete pictures every second. This means that the travelling spot on the TV screen makes 15,750 complete trips from left to right every second—a busy little spot indeed!

This spot of light is produced by a beam of electrons inside the picture tube. When electrons strike the chemicals (phosphors) on the inside surface of the screen, light is produced. The brightness of the spot is controlled by the intensity of the electron beam. And the beam intensity is controlled by a voltage on the grid of the picture tube—which is really a special-purpose vacuum tube. The nature of the picture on the TV screen is determined, then, by the pattern of voltage changes on the grid of the picture tube. This pattern of voltage changes is called the picture signal (video signal).

For a simple picture—one with a few large areas of light and darkness—the video signal does not fluctuate very rapidly. For example, an ordinary checkerboard, like that in Fig. 1, has four light and

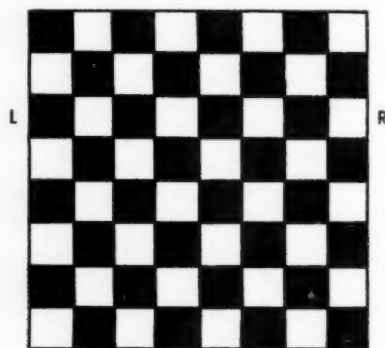


FIGURE 1

When a moving spot of light goes across this pattern—say from L to R, it becomes dark four times and light four times. This amounts to four complete cycles of fluctuation for each horizontal scanning motion. But most TV images are much more detailed than this checkerboard.

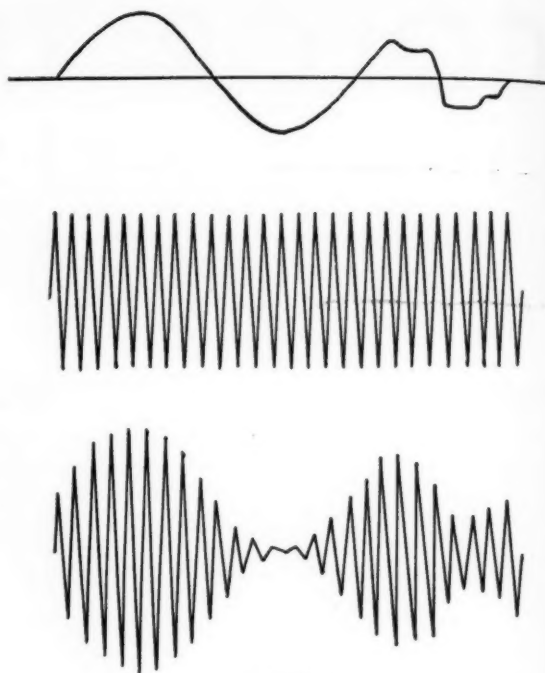


FIGURE 2

The upper figure represents a sample of an audio signal—a few vibrations of one syllable, for example. The center figure represents an unmodulated radio-frequency carrier wave. The lower figure shows how the carrier wave is modulated in accordance with the pattern of the audio signal. Note how the amplitude of the carrier wave has been modulated at both its upper and lower crests.

four dark patches as it is scanned from left to right. The corresponding video signal would evidently have four complete cycles of fluctuation for each line. This would make $4 \times 15,750 = 63,000$ cycles per second. But most pictures are far more complex than this. A real problem would be presented by a distant picket fence or a herd of zebra! The more fine detail there is to be reproduced in a TV picture, the higher the video frequency must be. Tests have shown that for optimum resolution of TV pictures, the video signal should have a frequency of essentially 4 million cycles (megacycles) per second. The achievement of this stern standard is one of the major technical problems in television. In practice, many receivers and some transmitters fall considerably short of this performance.

The Transmission of the TV Signal (2)

A video signal can be transmitted over electric wires if their characteristics are such that they will pass signals whose frequency is up to 4 megacycles per second. But commercial television involves *broadcasting* the signals—sending them over electromagnetic waves. For TV purposes, these trans-

mitted waves are from a few dozen megacycles to a few hundred megacycles per second. The problem, then, is to *superimpose* the video signal on the much higher telecast frequency. This process is called *modulation*.

A corresponding situation exists in the standard broadcast band of commercial radio. In the case of WGN, Chicago, the broadcast (carrier) frequency is 720 thousand cycles (kilocycles) per second. The sound (audio) signal is modulated on this carrier wave. Actually, the strength (amplitude) of the carrier wave is varied in a pattern corresponding to the audio signal, as in Figure 2. Hence this system is known as *amplitude modulation* (AM).

Some of the very important consequences of amplitude modulation are not recognized by many people. In Figure 3a, for example, it is assumed that an audio signal is modulated on a 720 kilocycle carrier wave. In the resulting modulated wave, there are frequencies of not only 720 kc, but also of 722 kc and 718 kc. These are respectively the *sum* and *difference* of the carrier and the audio frequencies. This situation is analogous to the formation of *beats* when two musical tones are sounded together.

Thus it is evident that an amplitude modulated signal requires certain "space" in the broadcast spectrum. The higher the frequency of the modulating signal, the wider the band of broadcast frequencies required. Commercial AM stations are restricted by *Federal law* to broadcasting audio frequencies of 5000 cycles per second or less. Even so, the band

of frequencies needed is 10,000 cycles per second wide, as shown in Figure 3b. The "spaces" above and below the carrier wave are referred to as upper and lower side bands. It is important to realize that the circuits of the transmitter *and* the receiver must be able to handle this band of frequencies if all audio notes up to 5,000 cycles per second are to be heard. Also note that a radio receiver tuned to—say—WGN does not receive only 720 kc; rather it receives a *band* of frequencies centered around 720 kc.

The video signal of television is amplitude modulated on its carrier wave. But since the video frequency goes up to 4.0 megacycles per second (mc), the band of frequencies required appears to be 8 mc wide! Naturally, the wider the band of frequencies needed by a single TV telecast, the fewer different channels can be fitted into those parts of the electro-magnetic spectrum assigned to television. Everybody seems to want *many* TV channels—yet they also want their pictures to have good detail—i.e. have high frequency video signals. Some means of reconciling the conflict between these two desires is very much in order.

The Black-and-White Television Channel (3)

The total band of frequencies now allotted to a TV signal is just six megacycles wide. For example, channel 2, no matter where it is located, operates between 54 and 60 megacycles per second. Figures 4a and 4b show how the 8 mc band described above has been compressed to less than 6 mc. The first of these illustrations shows a carrier with two 4 mc side bands. For convenience, the carrier wave is referred to as having a frequency of zero. In Figure 4b the lower side band is shown as being severely suppressed, but not eliminated altogether. The upper side band permits transmission of video signals up to 4 mc. This system of transmission is known as "vestigial-side band" operation.

The audio signal of a TV program is modulated on another carrier 4.5 mc above the video carrier, as shown in Figure 4b. This is done by frequency modulation (FM). In this system it is the frequency of the carrier wave rather than its *amplitude* which fluctuates in the pattern of the audio signal. In television, the audio side bands extend about 50 kc on either side of their carrier. Notice that there is some "spare space" between the video and audio signals; this keeps them from interfering with each other. Another "guard space" above the audio signal helps minimize interference from the next higher TV channel.

When a television set is tuned to—say—channel 2, its circuits receive the whole band of frequencies

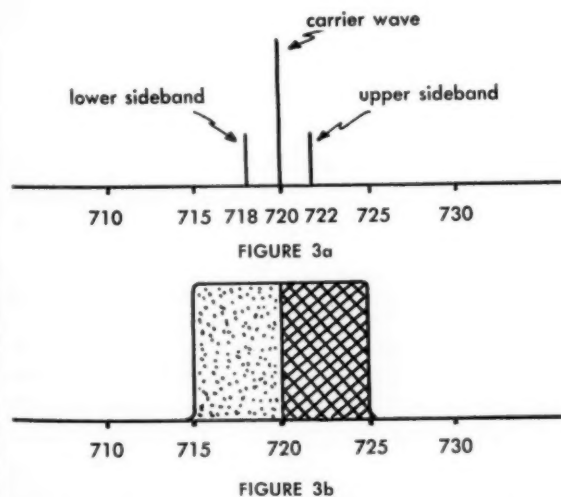


Figure 3a shows the location of two sideband frequencies when an audio signal of 2,000 cycles is modulated on a carrier wave of 720 kc. Figure 3b shows the extent of frequencies involved when audio signals up to 5,000 cycles are modulated on a 720 kc carrier. The crosshatched area is the upper side-band; the stippled area is the lower side-band.

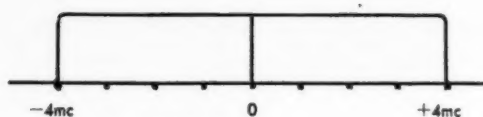


FIGURE 4a

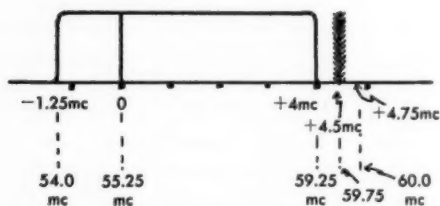


FIGURE 4b

Figure 4a illustrates how a 4 mc video signal amplitude modulated on a carrier wave might be expected to occupy an 8 mc bandwidth. In Figure 4b the lower side-band is partially suppressed. 4.5 mc above the video carrier is the audio carrier, which is frequency modulated. The shaded areas on either side indicate the spread of its side-bands. The upper limit of the entire 6 mc band is at 4.75 mc above the video carrier. Numbers at the bottom indicate how this 6 mc band is located in the frequency range of channel 2.

between 54 and 60 mc. The video circuits receive the carrier at 55.25 mc and its amplitude modulated side bands. At the same time the audio circuits receive the carrier at 59.75 mc and its frequency modulated side bands. Under proper conditions, all signals below 54 mc and above 60 mc are rejected by the selective circuits of the receiver.

The chart below shows the frequency allocations for the twelve "standard" TV channels:

Channel Frequency		Channel Frequency	
lower band	2 54-60 mc	upper band	7 174-180 mc
	3 60-66 mc		8 180-186 mc
	4 66-72 mc		9 186-192 mc
	5 76-82 mc		10 192-198 mc
	6 82-88 mc		11 198-204 mc
			12 204-210 mc
			13 210-216 mc

Channel 1 (at 44-50 mc in the early days of television) was abandoned and the frequencies turned over to other mediums of communication. The standard commercial FM band is just above the lower TV band, occupying the frequency range from 88-108 mc.

More recently 69 more TV channels have been authorized for service. These are in the range of *ultra-high-frequency* radiation, and are known as U.H.F. channels. Channel 14 is in the band from 470-476 mc. Successively higher channels are in progressively higher 6 mc bands, with channel 83

from 884-890 mc. The disposition of the 6 mc band width for the UHF channels is as shown in Figure 4b.

Early Developments in Color TV (4)

There are many possible systems of televising colored pictures. These have been understood in principle for a long time—most of them antedate commercial black-and-white TV. Each of them has considerable in common with the more familiar systems of color printing and color photography.

Proposed systems of color television have almost always involved the synthesis of a color image from components in each of three primary colors. These three are certain specified shades of red, blue, and green, commonly referred to as "physicists' primary colors". These differ from "artists' primary colors"—red, blue, and yellow. In the former case, colors are combined *additively*. But in the case of pigments, which are really like light filters, colors are combined *subtractively*. As an illustration of the difference, red and green pigments combined (*subtractively*) produce a muddy brownish color. But red and green lights combined (*additively*) produce *yellow*! Since a colored TV image is produced by additive combination of colored light, the physicists' primary colors are used. These are shown in the simplified diagram of Figure 5.

One simple way of producing color television would be to use three separate TV cameras, one for each primary color. The corresponding video signals could be sent on three channels and received on a triple receiver with three screens of appropriate color. When these three image components were

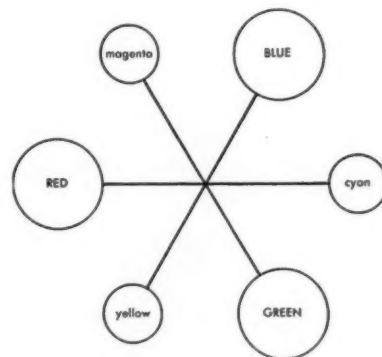


FIGURE 5

In this simple physicists' color wheel, three primary colors are shown in large circles. Any two primary colors when mixed in proper proportions produce the complementary color between them on the wheel. The secondary color *OPPOSITE* a primary color is complementary to it. A primary color mixed in proper proportions with its own complementary color produces white. All three primary colors properly combined produce white. All three secondary colors properly combined produce white.

combined, the result would be color TV. The system is sound in principle, but not in practice. Its chief drawback is that it uses up three precious television channels for a single program!

Faced with the apparent need of confining the color signal to a single 6 mc channel, engineers resorted to various kinds of *sequential* systems. This involves sending a *little bit* of each of the primary colors in rapid sequence. If the sequence is rapid enough, human persistence of vision integrates it into a steady, natural-color image. During the 1940's three kinds of sequential color TV systems were developed by independent groups. One of these sent a *field* of one color followed by a *field* of the next, and so on. A second employed a sequence of colored *lines*, while a third transmitted a sequence of colored *dots*. Respectively these came to be known as the *field-sequential*, the *line-sequential*, and the *dot-sequential* systems for color TV.

The system which received the most public attention was the field-sequential system proposed by the Columbia Broadcasting System. In the most common version of this, the sequence of colored fields were picked up by a modified black-and-white receiver. Color separation of the recurring images was accomplished by a rapidly whirling colored disk placed just in front of the picture tube. This disk had sectors of the three colors. Its rotation was synchronized so that a red filter was in position while the field corresponding to red was on the screen, a green filter for the green image, and so on.

The Federal Communications Commission (FCC) gave this system its official blessing on October 10, 1950, whereupon many people thought the age of color TV had arrived. But two circumstances operated to obstruct rapid manufacture of field-sequential TV transmitting and receiving equipment. One of these was the period of shortages brought on by the war in Korea. This resulted in government "freezes" in many branches of industry—television included.

The other reason for lack of enthusiastic acceptance of field-sequential color TV by industry and the public was that many TV technical authorities simply did not approve of it. Some disliked the rapidly whirling disk and reduced screen size (although these could readily be eliminated in the present state of the art). Others did not like the fact that the field sequential system demanded fewer lines per frame (405 rather than 525); this meant considerably lower definition of fine picture detail.

But most of all, coolness toward the CBS field-sequential system stemmed from the fact that it

was not *compatible* with the established system of black-and-white (monochrome) television.

The Significance of Television Compatibility (5)

It appears that the heavy majority of people in the television industry as well as the public want a color TV system which is *compatible* or "harmonious" with the existing monochrome system. Stated in another way, they want color TV which can be received *in black and white* on the approximately 30 million existing conventional television receivers. No modification of any kind should be necessary to use monochrome sets for color (multichrome) signals, and the quality of such compatible reception should be comparable to that of the best black-and-white reception. It is desirable that good black-and-white reception of monochrome signals also be possible with color TV receivers.

This attitude stems from the conviction that any move which would render existing monochrome TV even partially obsolete would be bad for the public, and hence bad for the industry as well. Many observers consider this a fine example of "enlightened self-interest" on the part of the television industry.

The CBS field-sequential multichrome TV system is not compatible with conventional monochrome television. This results largely from the fact that the number of lines per frame, the scanning rate, and the number of fields per second were different for the two systems. The conversion of a monochrome receiver to color would have involved relatively major circuit modification, as well as the addition of a whirling color disk and associated synchronizing circuits. This presented some serious problems in connection with picture tubes 12 inches and more in size. These and other considerations were well known to the Federal Communications Commission. Many persons were profoundly surprised that the FCC gave its official sanction to an incompatible color TV system. This seemed particularly puzzling in terms of the Commission's recognized responsibility for protecting the best interests of the public. (The Federal law establishing the FCC identified the communications portion of the electro-magnetic as "public property" and assigned the Commission the task of administering the use of this "property" in the public's own best "interest, convenience, and necessity".)

But for a variety of reasons, the FCC gave its approval to the CBS field-sequential color TV system. Almost immediately the representatives of certain incensed parties (among them, proponents of rival color systems) filed injunction suits against implementation of the new system. And almost

immediately the National Television System Committee (NTSC) began to study existing color TV proposals and to recommend technical specifications for a completely compatible color system. Virtually all the television companies participated in this effort, contributing not only funds, but talent, services, facilities, and hard-earned technical information.

As outlined above, the CBS field-sequential multichrome system did not really "take hold". Consequently, the NTSC had at least limited time in which to operate. On July 21, 1953, members of this Committee unanimously approved its comprehensive report and recommendations, which were in the form of a petition to the FCC. After allowing time for study of the recommendations, and for filing of possible counter-petitions, the Commission held performance tests in mid-October. It officially adopted the NTSC recommendations December 12 of the same year, then promptly waived the usual 30-day waiting period. Commercial color TV programs have originated in the East during late 1953 and have been relayed from coast-to-coast. The annual Parade of the Tournament of Roses in Pasadena, California, was the first West Coast-originated color TV program.

Color television is approved!

Color television is completely compatible!

Color television is here!

The General Nature of NTSC Color TV (6)

The natural question to be raised—and answered—at this point is, "How can all the necessary multichrome video signals be packed into a 6-mc channel, and still be compatible with monochrome TV?" An investigation of three important principles will lend some insight into this problem:

- a. The information necessary to transmit a color picture may be "coded" in several different ways to make up a multichrome signal. In Section 4 it was suggested that the signal might be made up of red, blue, and green components. But in the NTSC scheme, the color signal is made up of three other components as follows:
 1. *luminance*—how bright—how much light.
 2. *hue*—what color—red, purple, orange, chartreuse, etc.
 3. *saturation*—how much of the hue (in relation to white)—deep red, "red," or light pink, for example.

Of the above, the luminance signal is identical with the conventional black-and-white signal. No wonder this new color TV is completely compatible!

The combination of hue and saturation is referred to as the *chrominance* signal. It is important to

realize that this is not a *sequential* color system at all, but one in which all color information is transmitted *simultaneously*.

Although the color is *transmitted* in components of luminance, hue, and saturation, this does not prevent its being in other forms at other stages of the process. Actually, current models use color information in the form of red, blue, and green components both at the transmitting and receiving ends of the color system.

- b. Extensive tests have shown that the human eye demands much less fineness of detail in the *chrominance* aspect of an image than it does in its *luminance* aspect. That is, if an image has sharp detail in its monochrome structure, its color fill-in can be much coarser in character. (In a somewhat similar way, printers of color half-tones have found that the *sharpness* of the prints can be greatly enhanced by adding a black-ink image to those of red, blue, and yellow which impart the color information.) This means that a satisfying color TV picture can be produced by "filling in" a highly detailed monochrome picture with a much less detailed color information. In terms of frequency, this means that while a *luminance* side band of at least 4 mc is required, the *chrominance* side band can be considerably less (actually 1.3 mc). This considerably alleviates the problem of packing all the information into a channel only 6 mc wide.
- c. It is possible to make the luminance and chrominance signals literally share the same frequency "space" in part, at least. In Figure 4, it appears that the 4 mc side band is all "used up"—that "every cycle" is occupied. Actually, the side bands are clumped into strips at multiples of 15,750 cycles per second on either side of the carrier. Between these clumps there is "unused space." The same is true of the side bands containing *chrominance* information. In NTSC color, the "striated" side bands bearing color information are "dovetailed" or *interleaved* between the striated monochrome side bands. Thus, no additional channel width is needed. This principle is illustrated in Figure 8.

The Conversion of Color Information to a Video Signal (7)

The complete character of chrominance information and its conversion to a video signal is too complex to permit its full delineation here. This account is simplified as much as possible without distorting the facts that remain. While this description is grossly incomplete, its essential structure is correct as far as it goes.

The familiar array of colors may be represented as a physicist's spectrum, as an artist's color wheel, or as an interior decorator's color chart, as well as

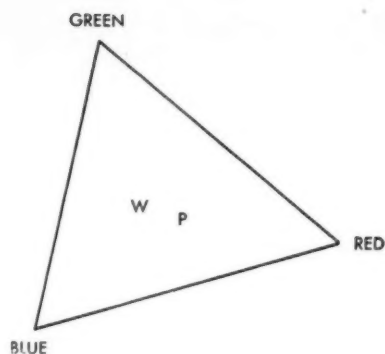


FIGURE 6

This color triangle may be thought of as a refinement of the color wheel of Figure 5. Primary colors are at the corners. Complementary colors are along the sides. Pale (pastel colors) are nearer the center, while the strong (deep) colors are nearer the edges. In this illustration, "W" represents white; "P" represents pink.

in other schemes. One useful method is to represent (most of) the natural colors on a triangle, as shown in Fig. 6. This places primary red, blue, and green at the three corners. White is near the center. Point P would represent pink, or unsaturated red. Shades of purple would be found in the general area bounded by B, R, and W. Yellow, chartreuse, and orange would be in the G-R-W region, with more saturated (stronger) colors nearer the G-R edge, and the paler tones nearer W.

In this way, every point in the triangle represents a color of some hue and degree of saturation. Now, if W be taken as the center of a system of polar coordinates, every part in the triangle can be represented in terms of an angle and a displacement.

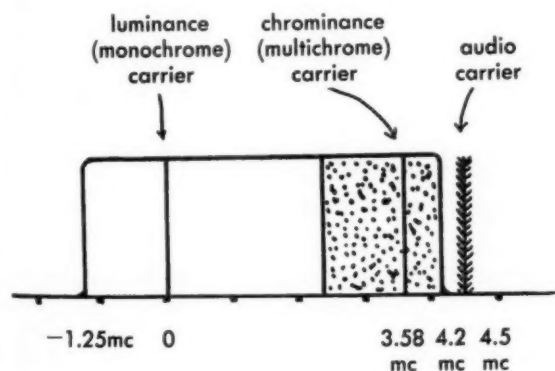


FIGURE 7

N.T.S.C. specifications allocate the frequencies within the 6 mc band as shown above. The stippled area indicates those frequencies which are shared by the monochrome and multichrome sidebands. Note that the multichrome signal is also transmitted by vestigial side-band modulation (the upper side band is partially suppressed).

That is, each color can be codified into terms of an angle (or phase relationship) which represent a *hue* and a displacement (or amplitude) which represents a degree of *saturation*.

In NTSC-TV, the hue (angle) information is phase-modulated (not AM, not FM) onto a chrominance carrier. The saturation (amplitude) information is amplitude modulated onto the *same* carrier. In the receiver, this information is "demodulated" and transformed back into three-primary-color information.

The Multichrome Television Channel (8)

The allocation of monochrome TV signals within a 6-mc band width has been discussed in Section 3 and illustrated in Figure 4. It should be noticed that the description which follows is completely consistent with the previous one. That is, the multichrome channel omits nothing that was in the monochrome, and no conflicting features have been added. Thus, the two systems are completely *compatible*.

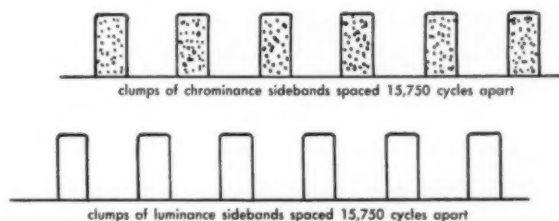


FIGURE 8

These illustrations indicate how luminance and chrominance sidebands can literally share the same "frequency space." Since the energy of both is "striated" in nature it is possible to "stagger" or "dovetail" the striations. Technically, this is known as interleaving. Note that the "striations" above are not side bands, but frequency-ranges in which side-bands may occur. Only a small section of the band-width somewhere between 2.3 mc and 4.2 mc is shown (refers to Figure 7).

The NTSC color TV channel is diagrammed in Figure 7. The big change as compared to Figure 5 is the addition of a chrominance carrier wave (usually called a sub-carrier). This is about 3.58 mc above the luminance carrier (actually $3.579545 \text{ mc} \pm 0.0003\%$). This location of the sub-carrier permits the *interleaving* of luminance and chrominance side bands as discussed in Section 6 and illustrated in Figure 8. Notice that the chrominance side bands are unequal (vestigial side-band transmission). Note also that the maximum chrominance side band permits a video frequency of only 1.3 mc. This is consistent with the principle that the color component of the picture need not have particularly fine detail (as discussed in Section 6, part b).

A slight difference exists in the upper side-band width of the luminance signal. This is 4.2 mc in multichrome as compared to 4.0 mc in monochrome. There are other differences between these two channel-allocations which are not evident in Figure 7 and which need not concern us here.

Picture Tubes for Color TV (9)

The NTSC recommendations do not specify any particular design of picture tube for color receivers. Fortunately, any one of several kinds can be used for modern multichrome. However, because the system is not color sequential, it appears that whirling disk methods of color rendition (see Section 4) have little or no place in modern TV reception.

One proposed tricolor tube (several types are in or nearly in production) has three electron guns (sources of electron beams) in the same tube. One gun is controlled by a red signal, one by green, one by blue. (Of course, electrons in all beams are alike!) But between the guns and the screen itself is a perforated plate, as shown in Figure 9. This contains some 250,000 holes each 0.009 inches in diameter! Since electrons can strike the screen only by going through the holes, the area of the screen

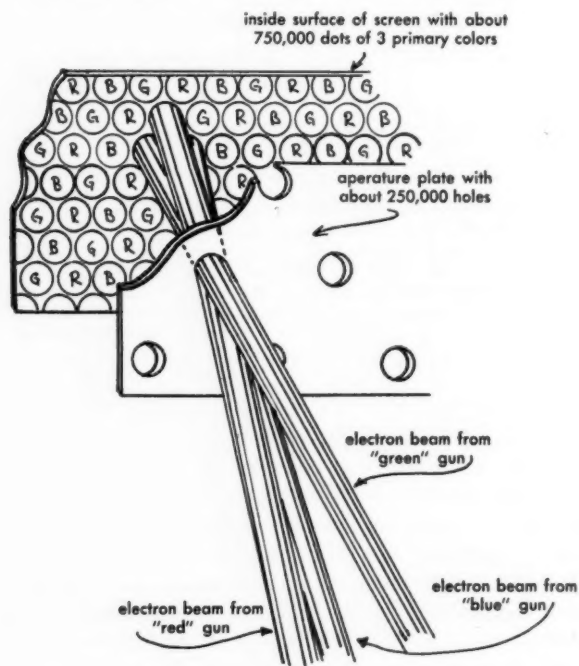


FIGURE 9

One common type of tri-color TV picture contains three electron guns. One electron beam is controlled by a "red signal," one by green, and one by blue. Because of the aperture plate between the guns and the phosphors, the beam from each gun can strike only those phosphor dots which glow with the corresponding color. The dots on the screen are somewhat smaller than the lines on conventional monochrome picture tubes.

which electrons from any one gun can strike is limited. Thus, electrons from the "red gun" can strike only 250,000 tiny spots on the screen, those from the "blue gun" can strike 250,000 other spots, while "green electrons" strike a third quarter-million spots.

Three kinds of phosphor are used inside the face of the tube. The 250,000 spots which can be struck by electrons from the "red gun" are coated with a chemical which produces primary red. Similarly, those spots in line with "blue and green electrons" are coated with blue and green phosphors. In this way, the video signal on the grid of the "red gun" controls redness on the face of the picture tube. The other two primary colors are controlled in a similar manner. The same tube is used for monochrome reception. When all three control grids are fed with the same monochrome (luminance) signal, their three colors combine to provide the range of grays from white to black—i.e. a conventional black-and-white television image.

The 750,000 dots which make up either a monochrome or multichrome TV picture are small—each has a diameter about 70% the thickness of a line in conventional monochrome reception. In comprehensive tests, 93% of a sample audience of 3000 persons indicated they noticed no dot-structure in NTSC color TV pictures.

Already it appears that color tubes can be made substantially as large as existing black-and-white models—although they are at this writing 4 to 10 times more costly, size being equal. There is nothing in the NTSC color system which precludes the development of projection type picture tubes making really large TV pictures possible. Advances in the chemistry of phosphors may suggest entirely new approaches to the production of multichrome pictures. It is abundantly evident that the design and production of colored TV picture tubes are still in the very earliest stages.

The Future of Color TV (10)

Now that color TV is actually here, it is more fashionable than ever to make predictions as to its future. But if past performance is any indication, some people in the television industry do a better job at producing TV images than they do at making accurate forecasts of future developments. Even when commercial TV started to grow just after World War II, there were some who predicted it was a fly-by-night gadget which couldn't pay its own way. Others prophesied that conventional radio was doomed. Seven production years later

(Please continue on page 90)

READING AND PLUGGING IN

—Through Elementary Science

By R. WILL BURNETT

I WAS recently advised by no less an authority than an elementary school child that formal education as he had experienced it over the many days of one school year, left a good deal to be desired. At the moment of my advisement, his disenchantment was particularly focused on his graded reading book. It read—and he showed me:

"Mary jumps the rope.
John jumps the rope.
Father jumps the rope."

My young informer finished the rope jumping business with an explosive, "The whole damn family jumps the rope," and threw the reading book onto the floor.

It wasn't that he objected to rope jumping. On the contrary, it was precisely because he considered that he knew all that he wanted to know about rope jumping already that he objected to the imposition of reading about it in such elementary rhetoric.

Now, I profess to no expertness in the teaching of reading. I am aware that in reading, as in other skills such as those required of the pianist or cabinet maker, a child's ability to perform is completely out of phase with his enjoyment of mature performance or in the product of the skill. A child may wish to read an exciting adventure tale or of how to take care of his pet turtle, but he must begin his reading on quite simple fare.

Nonetheless, my little friend had a point and a big one. For he was the same little boy whom I had seen looking forward to his first year in school with keen anticipation. As he had marched off to that first sampling of the school's wares he announced to his mother with mixed wonder and excitement in his voice: "They're gonna teach me to read and to plug in."

"To read and to plug in." Somehow the school was expected to remove the veil that prevented him from entering into the marvelous world of the printed page. He had been read to and he knew that behind reading lay a world of beauty, enchantment, and delight. Often his daddy had turned to the encyclopedia and to other books as he helped

the child find satisfying and sound answers to the constant barrage of questions a little boy asked as he tried to understand and comprehend an exciting and challenging world.

But the school had let him down. The things he was asked to read were not exciting. Nor did he get answers through this reading. Just that morning, for example, he and I had watched a beautiful orb weaver spider spew its silken shroud around a grasshopper that had become enmeshed in the sticky miracle of its web. Here was something worth learning about! Why didn't the spider get stuck in its own web? How could it make silk, anyway? How did it know enough to turn the grasshopper over and over as it wound its white net about it? Why did the spider wrap up the grasshopper? It didn't eat it. It just walked off to a neutral corner after awhile and sort of sat down.

As I say, the boy had his point. He had gone to school wanting to read—but for a purpose. The school apparently wanted him to just read words. But how about "plugging in"? It is possible, of course, that you don't know what "plugging in" is. This expression, straight from the child's world of inimitable phrases, refers to the process of attaching electrical appliances to electrical outlets.

It seems that this art had been frowned upon in my young friend's home. It may be assumed that his parents were aware of the danger that exploratory fingers which were permitted to "plug in" an electric cord, might also experiment with "plugging in" paper clips or other items poorly designed for the purpose. So this activity had been placed on the prohibited list.

I really do not know whether the school taught this child how to "plug in" and to use electricity with safety. I doubt it, for to my knowledge he never mentioned the subject again and it was, perhaps, a highly transient interest in any event. But it held the promise of substantial learnings, nonetheless. And I do know that this same youngster—and all the other little children over this wide country—are extremely curious about the world around them, and would tackle learning activities designed to help them know that world better with

relish and profit. I know this to be true and so do you. For we both know of teachers and schools where science activities have an important, central, and integral place in the elementary school program and where children are learning to get good answers to their very good questions.

The devil of it is that this situation is far from universal. In more schools than not, science if it is considered at all, is either a desultory reading program, or an occasional activity that starts nowhere in particular, leads nowhere in particular, and is more akin to an amateur magic show than anything else.

This disturbs me a great deal.

Let us go back to reading and reading readiness for our example. No child wants to learn to read, just for the sake of reading. (Nor does any child want to compute just to compute, write just to make marks on a paper, or even to be healthy just to have health.) It is true, of course, that children often want to do what their older friends and parents do, whether they see meanings other than "belonging" in doing these things or not. But beyond this I must insist that no child is learning the mechanical skill of reading or anything else for its own sake. The child wants to read for the same reason that you and I want to read. We turn to books and other printed materials in order to share, vicariously, the rich experiences of mankind. Or we search for materials that answer our questions and help us to do the things we want to do. It is the same with the child. *Reading readiness is a function of what a child is interested in or can be brought to have an interest in.* And here is where science comes in. For there is considerable evidence in both research and experience to show us that children's interests lie heavily in what we may call the scientific aspects of their world. The child's world is, indeed, primarily a phenomenal world. And the child is bent on interpreting and understanding phenomena. By and large, our elementary schools give him rather good help in the social, artistic, and even constructive techniques he needs for his explorations and interpretations. But, for reasons I shall want to explore with you shortly, comparatively few schools are giving children the help they need in interpreting the scientific aspects of their living. Too few teachers have learned the rich teaching advantage in capitalizing on this genuine thirst for dependable knowledge about the natural world in fostering such things as reading, writing, and arithmetic.

Look again upon my little friend. I don't think that he is atypical. He really wanted to learn to read and he really wanted to learn to "plug in." In

the largest sense, he wanted to read so that he *could* "plug in" and do the many other things he wanted to do and understand the many other things he wanted to understand.

How fortunate a set of circumstances for the elementary teacher! To over-simplify the case to get at the point, all she had to do was to provide my friend with some simple electrical equipment, some direct help, and some properly prepared simple reading matter related to a first-grader's interest in electricity. Then were the educational process of finding out and of reading *both* well under way.

I think that we can use "reading and plugging in" in a generic sense to represent the many skills and understandings that are necessary or desirable for effective living in our world today, and turn our attention to the important questions of why science is too seldom found as an integral and central part of elementary programs and of what we might do to help teachers place science instruction in the position it merits. The problem has repeatedly been under scrutiny, symptomologically at least, and the results of the many inquiries have shown considerable consistency. The reasons for limited science programs can be categorized as follows:

(1) Elementary teachers are inadequately prepared in science fields. (2) They are afraid of attempting to direct science learnings for they *feel* their inadequacy. (3) The relatively few formal courses in science that they may have had were often poorly designed to help them work with little children bent on understanding and interpreting their world. (4) The elementary school curriculum is already packed to the gills and running out, and it is difficult or impossible to "add" science to the program. (5) There are good reading books, spellers, arithmetic books, and so forth, but very few adequate references in science properly geared to the abilities and needs of young children. (6) Time, funds, and lacks of personal know-how on the part of the teacher prevent the preparation and use of equipment for carrying out science activities. There are other reasons why elementary teachers may ignore or inadequately treat science in their teaching, but these are the chief ones.

How valid are these reasons? If a teacher thinks them valid, they most certainly are preventing him from doing a good job with science teaching; so, in this sense, they are all valid. But let me briefly present a point of view on the actual validity of each.

(1) "Elementary teachers are inadequately trained in science." Of course they are and through no fault of their own. With notable exceptions, the elementary teacher in training simply hasn't

Anyone listening to the papers presented by R. Will Burnett, Donald Stotler, and Kenneth Anderson at the NSTA Regional Conference at the University of Colorado last October surely would have pondered the thought, "When have I heard three such penetrating analyses of the basic goals and methods of science instruction?" We are happy to bring these three to you in their entirety in one issue of *THE SCIENCE TEACHER*.

Dr. R. Will Burnett is Professor of Education at the University of Illinois. He edited NSTA's *Selected Science Teaching Ideas of 1952*; is serving on this year's operating committee for the student Science Achievement Awards.

Dr. Donald Stotler (his article begins on page 68) is supervisor of science in the Portland, Oregon, Public Schools.

Dr. Kenneth E. Anderson began his career as a chemistry teacher in Minnesota; moved to the University of Kansas where he is today Dean of the College of Education. His contribution begins on page 71.

had the time or the guidance to take a rounded program in science.

(2) "They are afraid to try teaching science because they know they are poorly prepared to do it." Of course. Would you like to be pressured by a principal, yearbooks, or even a course of study to teach Athenian culture or Hindustani if you had taken few or no courses yourself? Pressure upon a teacher to handle an area in which he has insufficient background will not result in a miracle of good—or even passable—teaching. On the contrary, unless some good and direct help is forthcoming to the teacher, the results may be so catastrophically bad that it had been better not to attempt it at all.

(3) "The college courses elementary teachers have taken were logical disciplines designed for purposes other than those of the elementary teacher." Less true than in former years, but still probably more of a rule than an exception.

(4) "There is no room for science in the curriculum." Complete nonsense! This viewpoint represents a naive notion of what a sound elementary science program is. Properly integrated science activities and learnings not only deserve a place in the curriculum, crowded as it may be, but they actually support and facilitate other proper phases of elementary instruction through the tremendous motivation and reality they provide. The child's world is not divisible into the social, esthetic, scientific, moral, and quantitative except for purposes of

analysis. Many modern elementary schools have found the important truth that a good deal of the child's education can best be carried on in a cohesive and integral program that is reflective of the real world outside the school room walls. Where this is done you just can't keep the science out. It doesn't push the curriculum around. It is one of the necessary cements that knit it together, give it vitality, and make it truly developmental as the child is himself.

(5) "There are inadequate reference materials for the use of children." If we are thinking of basic readers, and so forth, yes. Much needs to be done to get the authors and publishers of basic texts to incorporate a good deal more science and a good deal less "rope jumping" to challenge the child and lead him on.

But there is, today, a veritable mine to be worked by the elementary teacher and her children. I am speaking of the quite excellent, varied, and numerous trade books in science written for children today. More are needed and more are forthcoming. But our schoolrooms should be lined with these delightful books, with good encyclopedias designed for children but written by experts in their fields, and with standard references of all sorts that can be used by the teacher and the able child as well. The big problem is simply to see to it that the mine is worked. The reference tools are generally available and but await the discovery of the teacher.

(6) "There is neither the time, money, nor skill to prepare and properly use scientific equipment appropriate for elementary school work." True, to a great extent, despite the excellent references the teacher might use to help him in his task. It is one thing for you and me to point out how simple it is to make a simple electric motor out of nails, bell wire, tin cans, corks, and a dry cell. Anything is simple once you know how. It is quite another thing for the teacher who may have been scared into avoidance and antipathy of science through a technical college science course or, even worse, may never have taken a physics course in her life.

Well, what are we to do? Those of us in this room are aware of the importance of good science teaching in the elementary school. I assume that we are in fundamental agreement on the problems that prevent increasing the number of schools where good science teaching is done. If we agree on the diagnosis, what about the therapy? What, more specifically, can the National Science Teachers Association do as a national and representative organization of science teachers throughout the United

(Please continue on page 97)

WHAT SHOULD HIGH SCHOOL SCIENCE DO?

By DONALD W. STOTLER

WILL you join me for a little while in speculating about the high school science program in terms of three of the great problems of current society? If America is to remain strong and become an effective salesman of world freedom it will need to (1) increase the *quality* of its pure scientists, (2) increase the *quantity* of its applied scientists, and (3) improve each citizen's ability to use science more wisely in daily living.

1. *Why have so few of the great creative ideas of pure science come from America?* I once asked this question of a high school biology class and received two especially plausible answers. One, that America has been and still is a frontier country and necessarily preoccupied with practical applied science rather than the more detached theory of pure science. The second, that money is the usual incentive in America and therefore scientists tended to concentrate upon the development of scientific applications, since they were eagerly bought by industry, whereas the theoretical ideas of the pure scientist were usually not immediately usable, and in fact were often resisted. Cash rewards in pure science are seldom immediate or large, and a scientist requires the security of another job (usually college teaching) in order to afford the luxury of pure research. The student had not been to college yet or he might have added that, when college teaching and research are combined, the teaching tends to become a mere avocation, often giving students who are potential scientists a distasteful experience with "cookbook" pure science as experienced in the classroom.

Before being unduly critical of the college concerning this problem, however, it might be well to look at the high school. Here it has evidently been the assumption that, since pure scientists seek knowledge for the sake of knowledge, the best way to train pure scientists is to give them science for the sake of knowledge itself. The textbook-workbook combination has been considered ideal for this purpose—but is it? One of the disturbing aspects of education is that the obvious is so seldom true. How could the memorization of facts already discovered develop pure scientists when pure scientists must have an intense curiosity, outstanding self-reliance, and exceptional skill in using scientific procedures? Hypothesizing and theorizing are the crux of scientific method and creative thought, and

yet this is the very aspect of science most discouraged in the high school. In fact, hypothesis and theory have become derogatory terms in America. What will squelch anyone more quickly than to say, "That is theory, isn't it?"

To put the problem another way, science and philosophy are very closely related. When a scientist has collected the data concerning a problem, and is pondering which of the many possible answers to the problem seems most worthy of first experimentation, he is actually a philosopher. He is philosophizing in the face of alternatives. In fact let's go a step further—is a pure scientist *really* interested in knowledge just for the sake of knowledge, or is he basically a philosopher seeking to understand the universe and man's place in it? To make existence intelligible?

At this point it might be well to re-examine a phase of ancestral "good-old-days." Science began in America as NATURAL PHILOSOPHY. The relationship of science and philosophy was recognized in those days. In fact, to go back to scientific beginnings, Newton's description of scientific method in his book, *Principia*, refers to science as EXPERIMENTAL PHILOSOPHY. Philosophy has been discarded in America and retained in Europe. If we would reinstate philosophy in American high school science, at least three advantages might be expected: (1) a more functional understanding of science, (2) a source of intense motivation to adolescents; for one of the pressing desires at this age is the development of a philosophy of life—an orientation to society and the universe, and (3) science courses centered around philosophical problems, which might also help to answer the increasing demand for the study of moral and spiritual values. Such study would not be in terms of science versus religion, but incidental to the discussion of science hypotheses and theories versus themselves. Perhaps, at least, the students could be brought to agree with Voltaire, who said in his book, *The Ignorant Philosopher*, "It would be very singular that all nature, all the planets, should obey eternal laws, and that there should be a little animal, five feet high, who, in contempt of these laws, could act as he pleases."

Every student, not just the potential pure scientist, can benefit in terms of attitudes and appreciations from the exploration of such problems of

science-philosophy as the following: How are living things related? To what extent can the human race be improved? Are the world's sources of power inexhaustible? Is science more constructive than destructive?

2. *Why aren't we producing more applied scientists?* A large part of our daily activities are based upon or made possible by the procedures and findings of science. It would seem probable that, with science on the upsurge, students would be rushing in overflowing numbers towards careers in science. However, the grim truth is that so few people have been choosing science as a career that it has begun to emerge as a major threat to the welfare of this nation.

Since the initial college enrollment in science is rather small we must pass over that usually convenient scapegoat and look at the high school. Here again we must look at science courses too often based on science knowledge for the sake of knowledge. Such courses could scarcely be expected to thrill most potential applied scientists. In my experience, most applied scientists are crusaders at heart. Potential applied scientists would be as thrilled with units based upon problems of a crusade nature concerning the possibilities of overcoming the struggle for existence as a potential pure scientist would be with units based upon philosophical problems attempting to make existence intelligible. A few examples of crusading problems are: How much can machines reduce work? To what extent is weather controllable? Can disease be destroyed?

Neither the potential pure scientist nor the potential applied scientist would be satisfied with discussion and speculation alone. There must be opportunities for initiation, experimentation, and manipulation relative to the problems being explored. This a closely budgeted high school schedule seldom provides. Larger time blocks are badly needed if creativity and initiative are to be recognized. This probably will be accomplished in time by combining science courses with other courses such as social studies and mathematics. Until larger time blocks are arranged, science fairs, science clubs, and encouragement of hobbies are hopeful avenues for building creativity and initiative.

The problem of counseling offers another frustration. The counselor is more likely to be a social studies major than a science major by virtue of his training, and often doesn't understand the various science courses and the opportunities afforded in them. In any event, the best counseling is usually done in the classroom and we must renew this effort. General science, especially, would be a more effective course if it were mainly concerned with arous-

ing scientific curiosity; exploring career possibilities through literature, community resource people and field trips; and stirring interest in further high school science courses in terms of student ability and interest.

3. *Why are we not producing citizens better equipped for our scientific age?* Even a casual examination of most any newspaper is pretty convincing proof that scientific developments have swept far ahead of the education of the great bulk of the people. And in a democracy the great bulk of the people are the very ones who determine how science will be used.

These people will never be applied scientists, certainly not pure scientists, yet they can be stimulated by both philosophical problems about their place in society and the universe and problems of a crusade nature that look to overcoming the struggle for existence. The over-riding problems that are necessarily forced upon the bulk of the people, however, are immediate ones concerned with merely being comfortable in the struggle for existence. Following are some examples of immediate problems: How is good mental health achieved? Is it necessary to be informed about the construction and maintenance of our homes?

A sound high school science program would seemingly stress units centered around all three basic types of problems—philosophical, crusading, and immediate. This brings up another question. Aren't these really social studies problems? Are we usurping another subject? Perhaps at the high school level it is about time we did usurp more of each other's subjects!

In scientific procedure we state the problem, gather relevant data, and then explore the possible answers as precisely as possible in terms of the data. Our studies on transfer of training indicate that this should be a unified rather than a fragmented approach. Yet the most common criticism of science is that it is "just cold facts"; the most common criticism of social studies is that it raises the problems and discusses the possible answers and "you walk out the same door you came in". This division of the data gathering phase of problem solving, on the one hand, from the statement of the problem and the exploration of hypothetical answers, on the other hand, asks too much of the typical learner. Perhaps this is one reason why most people are unable to use science more effectively in daily living. If science and social studies are to be separate, why not select the problems needed for study in high school and then put those problems that sound more "scientific" in science and those more "social" in social studies? In time those science and social

studies courses of a general education nature can be combined into double periods under the guidance of one teacher to enable longer time blocks, and so encourage more initiative and creativity.

The relationship of science and social studies may also be approached in another way. In the pre-atomic era time, space and energy were regarded as separate entities. The theory of relativity brought the fusion of these entities because many problems could not be solved unless they were unified. In the search for a "hook" to hang the sequence of the curriculum upon during the pre-atomic era, different subjects selected different hooks. *Time* was chosen as the hook for history courses—and indeed there is currently a move to "modernize" our science curriculum by using an historical approach. *Space* was chosen as the hook for geography courses, and the expanding space concept is still the basis for many elementary and high school social studies sequences. *Energy* was chosen as the hook for the science sequence—sound, light, machines, the halogens, and so on.

Does it not seem feasible that the theory of relativity should also affect the curriculum? Wouldn't it be more effective to look at the characteristics of the students and the problems confronting them and let these problems be the "hooks" upon which the curriculum might be built? These problems would utilize time, space, and energy, but in a context. Problems are not respectors of subjects such as science, social studies, and mathematics; nor of sequences based on such concepts as time, space, or energy as such; nor even of subjects such as general science, biology, and physical science. A four-year sequence of science for general education seems to be the emerging pattern, and as larger time blocks are needed general courses in science, social studies, and perhaps other fields can begin to combine into a half-day core. This would not necessarily be to eliminate the more specialized courses, especially in the last two years of high school.

However, would a curriculum based upon problem solving and the use of scientific techniques produce the type of citizen we need so desperately? John Dewey exclaims, on page 100 of his book *Experience and Education*:

"We are told almost daily and from many sources that it is impossible for human beings to direct their common life intelligently . . . This view would be more credible if any systematic effort . . . with early education and . . . continuous study . . . had ever been undertaken with a view to making the method of intelligence, exemplified in science, supreme in education."

Let us look at some of the educational implications of a problem solving curriculum:

1. The problem solving approach is essentially the procedure of the laboratory scientist and the active citizen in a democracy. The teacher is a consultant who helps the students practice the arrangement of the ingredients of scientific method by actual use in coping with individual and group problems. The students and teacher (1) develop a common problem or area of concern, (2) define the problem so it is clearly understood, (3) bring together the data, experimenting where appropriate, (4) evaluate it as to its relevance to the problem, (5) explore the possible answers to the problem in terms of the data, (6) devise procedures for checking the different possible answers, (7) compare the results with the known in as precise a manner as circumstances permit, (8) share the procedures and findings with other people. Not as effective as science in a laboratory perhaps, but the fact that a snowplow cannot cut as precisely as a razor does not mean that only razors should be used. Obviously the teacher cannot at the same time be a dictator, standing in front of seats fixed in rows, with the occupants memorizing "right" answers from a text.

2. The physical furnishings of such a classroom need to be very flexible. For instance, when the class is arriving at a statement of the problem, the furnishings might be arranged in a large circle so there can be face-to-face discussion. Business executives have known for years the advantage of a roundtable when discussing a common problem. Later there is need for several small group circles to work on different aspects of the problem. Then again rearrangement is needed to permit demonstrations of experiments; for reports; and for other activities such as panels and debates as various possible answers are explored.

3. Problem solving requires a partnership between school and community. The community is invited to visit the school and they respond in like spirit. The schools are owned by the people and they owe it to themselves to visit and participate in their own investment. This is especially true since the modern school, like democracy, is ever in a process of change and readjustment. Where there is movement, there can be "slanting" in certain directions unless there is participation by all segments of adult society.

The teacher and students are interested in public participation for another reason also. The commu-

(Please continue on page 100)

IMPLICATIONS FOR TEACHER EDUCATION IN SCIENCE

By KENNETH E. ANDERSON

LET us suppose for the moment that I believed I had been in hell. You no doubt would take with a grain of salt my vivid description of what hell is like. However, I must remind you that the existing evidence of what hell is like is still quite limited.

Herein, however, lies an attitude basic to the exploration of our problem: that much is yet to be learned in the training of teachers and that an effective program of teacher training can only emerge through exploration which is rigorous and genuine in nature.

Those of us concerned with the teaching of science in the schools must by necessity operate within a frame of reference or hang our program on some firmly fixed hook, in order that we might operate effectively and have faith in what we are doing. To state the objectives of science teaching as they have appeared in learned yearbooks and articles is but to repeat the time-worn clichés given in so many of our methods courses. At the risk of introducing a new cliché, let us say that we are most concerned with teaching for understanding in science and with the transferability of these acquired understandings of science to the problem situations of everyday life. Herein lies the key to the program of teacher training in the field of science. Here is the firmly fixed hook or frame of reference for planning a course of action in the training of science teachers for the schools.

To be more specific with regard to the nature of this frame of reference, I quote verbatim from the recent yearbook of the NEA Department of Elementary School Principals entitled *Science for Today's Children*.¹

"Science is not a mere collection of isolated facts and observations, but an interrelated body of knowledge capable of test and possessing considerable scope, precision, and coherence. In the elementary school some appreciation of the scope, precision, and coherence of science is desirable; but the main objective should be the operation of the *big ideas* of science in the lives of boys and girls here and now. The level of understanding of the *big ideas* of science and their application to daily living will be

lower in general for the elementary-school pupil than for the secondary-school pupil; but, even here, considerable overlap will occur in terms of individual differences in ability and interest.

"One might ask the question: 'Why stress the *big ideas* and their application?' Heretofore our criteria of learning have been limited for the most part to rate and accuracy. For example, how many facts do we know and how quick are we in recalling these facts? In other words, we as teachers of science in the elementary school have stressed *what*, *when*, *where*, and *who* questions rather than *how* questions.

"By *how* learnings we mean how facts and events are related to one another—how something causes or comes from something else, or how a change in one situation is associated with change in another. How, for example, does the draining of swamps or the cutting of trees result in changes of great importance to plants, animals, and man living in an area?

"By *how* learnings we also refer to the methods and procedures that are used in solving problems, in getting information and understanding, and in putting these to work in living. For example, too often our teaching has stressed the location of planets and stars and their discoverers rather than an understanding of the solar system or the universe. Our teaching has stressed the fact that tuberculosis is caused by a specific organism discovered by Robert Koch in 1882 rather than an applied understanding of the germ theory of disease. We have stressed the fact that the electromagnet is a useful device perfected by Joseph Henry rather than an understanding of the principle of science which makes it operate.

"To be sure, these facts are important, but educational research has shown that the retention of *big ideas* is greater than that of factual information. As more *big ideas* become incorporated with those already acquired, the retention of *big ideas* may increase even more.

"It matters not that the child does not know the whole of science. What does matter is that what he knows and understands is his, and that it has potency in directing his daily activities in such areas as health, safety, conservation, and freedom from superstition and ignorance. When he begins to use them intelligently, his understandings of science have value. His knowledge of the germ theory of disease or his knowledge of moving objects may thus actually save his life today or tomorrow. His

¹ Kenneth E. Anderson and Gordon M. A. Mork. "Evaluating Science Teaching." *Science for Today's Children*, Bulletin of the Department of Elementary School Principals, Vol. XXXIII, No. 1, September 1953, pp. 139-145.

knowledge has value as he uses it to preserve himself and to live a more useful, pleasant, and responsible life.

"As the child grows, one labels him as practical and resourceful. He can do so many things so well. Actually, partly because of his greater understanding of science, he has shown adaptability. He can now put his understandings to work with greater ease and in a greater variety of ways. In later years this may prove to be the most of what he has left of his schooling in science. He may, because of his understandings, be able to adapt himself to the changing conditions of his environment. We say, then, that he is learning to solve life's problems. This principle has long been known to be in operation with regard to plant and animal life. The plant or animal adapts itself to a new or changed environment or it dies. Man, in a short life span, must also be adaptable if he is to survive and live his full three score years and 10.

"The above discussion has shown in a sense the evolution of the psychology of learning and represents the steps a child must take in becoming a partially adaptable person. In other words, our criteria of learning should be extensive enough to include the following:

1. Has the child acquired and retained useful and pertinent science *information* of a factual nature?
2. Has he acquired and retained a workable understanding of the principles or *big ideas* of science?
3. Has he learned to use intelligent methods in adapting to the problems of his life?
4. Has he reached a level of understanding, application, and performance in the above three which is commensurate with his *ability*?

"All these criteria of learning should be used in evaluating the growth of children in science with the purpose in mind of developing adaptable youngsters. Does he have *psychological ownership* of what he knows? That is, does he use his knowledge to meet the changing conditions of his environment, and does he have confidence in this knowledge?

"A teacher of elementary-school science is, of course, interested in all these criteria, but his daily contacts with pupils will be pitched on one of these levels depending on his own understanding of science and his ultimate goals in the teaching of science."

Inherent in this frame of reference and particularly in the criteria of learning listed are implications for teacher education in science.

By a simple substitution of nouns, these criteria may be made to read as follows. Has the science teacher:

1. acquired and retained useful and pertinent science *information* of a factual nature?

2. acquired and retained a workable understanding of the principles or *big ideas* of science?
3. learned to use intelligent *methods* in adapting to the problems of his life?
4. reached a level of understanding, application, and performance in the above three which is commensurate with his *ability*?

These are some of the criteria that I would use in judging the soundness and effectiveness of the training teachers receive in science courses on the college level.

In terms of the professional job the teacher must do in the public schools, it matters not that a teacher does not know the whole of science. What does matter is that what he knows and understands, is his to be shared with his students, and that it has potency in directing his teaching activities. When the teacher begins to use them intelligently in his teaching, his understandings of science and the world about him will have value for his students. His knowledge of science will have value only insofar as he effects a change in behavior of the students under his direction. Do the children: ²

1. Recognize problems or show curiosity about their daily surroundings?
2. Suggest answers or methods of problem solving, rather than use "fairy-tale" answers?
3. Differentiate between the value and reliability of different sources of information?
4. Draw conclusions carefully or jump quickly to conclusions?
5. Use learning, rather than just *recite* learning?

Do the children show an increasing appreciation and understanding of such points as these? ²

1. Natural events, such as thunder and disease, have natural causes.
2. New discoveries and inventions require us to change our ways of living.
3. Science has been developed by people of many nationalities and groups.

These are some of the criteria that I would use in judging the soundness and effectiveness of the professional training teachers receive in schools of education and teachers colleges.

In addition to a sound background in the sciences and in the professional courses in education, I would want the science teacher to have an adequate grasp of the major insights of other fields such as sociology, economics, and history. The science teacher of today can no longer live just in a world of science but must have the stamp of the humanities clearly imprinted on his mind and ways of living.

² *Ibid.*, p. 145.

How might all this be accomplished in teacher education programs in science? Since science is not a mere collection of isolated facts and observations but an interrelated body of knowledge, teacher training programs in science must insure that the student samples widely the various branches of science and that in addition he sinks a shaft of sufficient depth in one branch of science so that he has *psychological ownership* of what he knows. That is, he has a sufficient depth of knowledge in one area of science and a sufficient base in other areas for further growth and development on his own. To be sure, the teacher training program for the elementary school level need not and will not be able to accomplish this goal to the same degree as the teacher training program for secondary school level. It is important, however, that teachers on both levels have sufficient training in science to the end that they have confidence in their ability to teach science. How any one teacher training program will accomplish this goal is hard to say. Certainly, the pattern of training in science for teachers from college to college will not be identical nor should it be. Some colleges will develop science survey courses specifically designed for teachers and others will by necessity continue to place teachers in science courses designed for students not necessarily in teacher

training programs. College courses in science for teachers as well as for other students should emphasize:³

1. Laboratory instruction. Students can gain real experience with scientific phenomena only in proportion as they deal with phenomena in a truly scientific manner, which means an increased emphasis on the method and spirit of science. This means much more than methodically following the steps in the scientific method. It means the solving of original problems rather than the repetition of experiments performed by scientists in the past.
2. Actual experience in the use of the elements of the scientific method. A teacher who has not experienced original investigation can be no more than a two-legged textbook.
3. Sound techniques of developing within the student an understanding of the principles of science along with its method. This would include the proper use of the adjuncts to science teaching such as the field trip and the science club, as it is through these channels that students often do original work.

If we are mindful of the criteria stressed in this discussion for judging the soundness and effectiveness of the science and professional training of teachers, and if we are mindful of the ways for increasing the vitality of science courses for teachers, then our teacher training programs will produce the kind of science teachers needed in the schools.

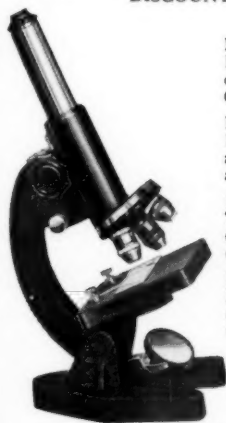
Finally, the professional training of the science teacher as well as the training he received in science, should have given him an open mind or an attitude that does not encompass a completed world of knowledge—all is known. He should be sensitive to the phenomena of individual differences and by virtue of his training, devise better methods of teaching the variety of individuals under his direction. Science teachers should, by the very nature of their training, be producers of the finest types of educational research. They should be expected to investigate as well as teach.

Therefore, let us who are teachers of science and trainers of science teachers devote time and energy to increase our knowledge of students and the methods and materials of science instruction. Let us all who are interested in shaping and directing human behavior be interested in individuals first and specialties second; let us have a broad knowledge in our field and insight into other branches of knowledge, and let us be militant in our efforts to provide the best possible science instruction for the youth of our country.

³ Kenneth E. Anderson. "Improving Science Teaching Through Realistic Research." *Science Education*, 37 (February 1953) 55-61.

SERVING SCHOOLS AT LOW COST

A DISTINGUISHED LINE OF AMERICAN-MADE,
LOW-COST SCHOOL MICROSCOPES.
LABORATORY SIZE, WITH LARGE, PROFESSIONAL
INCLINING STANDS, PRECISE INTERCHANGEABLE
OPTICS.
INSTRUCTION MANUAL FURNISHED. QUANTITY
DISCOUNTS TO SCHOOLS.



MODEL F—100 to 700X. \$92.50
Parfocal triple nosepiece. Condenser stage with iris diaphragm. Coarse and fine adjustment.

MODEL H—50 to 700X. \$82.50
Parfocal double nosepiece. Low and high power objective. Coarse and fine adjustment.

MODEL G-3—100 to 400X \$59.00
Triple divisible objective. Substage diaphragm turret. Most economical high school microscope.

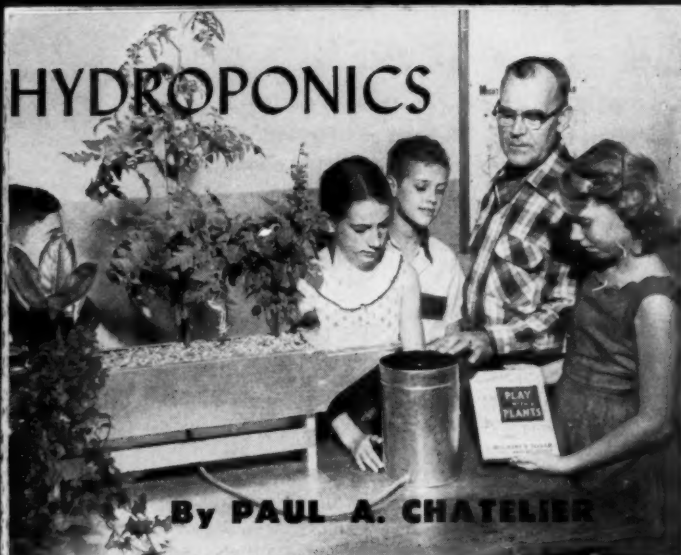
MODEL S-2—75 to 250X. \$33.50
Double divisible objective. Simple and efficient for elementary science use.

SUBSTAGE LAMPS AND
OTHER ACCESSORIES

Write for literature to Dept. S.T.

TESTA MANUFACTURING CO.
418 S. Pecan St., Los Angeles 33, Calif.

HYDROPONICS



By PAUL A. CHATELIER

HY-DRO-PON-IC means the growing of plants without soil and fed with a complete nutrient solution. This means feeding your plants a plant food that contains all the necessary elements that will keep them alive, from a tiny plant through maturity. When growing plants by this method, use coarse builder's sand, silica "chats" gravel, or sphagnum moss. The material is used solely for supporting your plants.

The containers illustrated show you what to use when starting your plants and how to grow plants hydroponically in a small way. Illustrations "A"



"A"



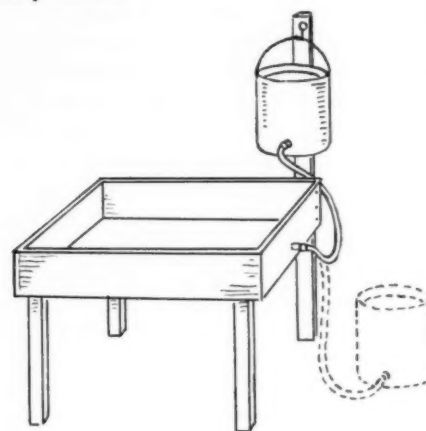
"B"

the roots, due to lack of oxygen; consequently the plant dies.

The 8-inch standard pot ("B") can be used for plants that produce longer root systems such as

carrots, peppers, tomatoes, hibiscus, crotons, and most shrubs that you care to grow from cuttings. The 8-inch Azalea ("A") pot is low but broad. This kind enables the roots of your plant to spread out a little more than when a narrower container is used.

This kind of pot can be used for the growing of lettuce, parsley, small onions, herbs and small flowering plants, ivy, ornamentals (small variety), and many others.



"C"

Illustration "C" is a set-up for a small hydroponic garden or class project for interested gardeners.

Material needed: wooden box 3 feet long and 10 or 12 inches wide, 4 wooden legs of equal length nailed to box. A "V" shaped trough should be placed in the center of the unit from end to end, thus permitting solution to flow freely under gravel. Box should be painted with asphaltum paint to avoid any toxic condition plants may absorb from the unit; the paint will also preserve the unit. Gravel should be used in the box. A galvanized or enameled bucket (capacity depending on size of unit) should be used to hold the plant food solution. If galvanized bucket is used it should be painted with asphaltum paint. A flexible hose is attached to bucket and box as illustrated in the photograph. Bucket is hung on hook above box of gravel where plants have been placed, so solution runs by force of gravity into gravel, where it should remain for about 2 minutes to allow roots of plants to soak up plant food and allow gravel to be well saturated. After 2 minutes, the bucket is then placed below the box to allow solution to drain back into bucket from the gravel. This process is repeated as often as plants show need of water and nutrients besides the regular daily feedings. A box this size is limited to plants that will not wilt if left over the weekend without watering.

Amount of plant food to use: In potted plants, use 1 teaspoonful to 1 gallon of water, or ¼ teaspoon to 1 quart of water. For illustration "C" hydroponic garden box, use 1 tablespoonful of plant food to 1 gallon of water.

Location: A bright sunny location must be chosen to give the plants all the light and air they need.

For rooting cuttings: Use 1 teaspoonful to a gallon of water.

For transplanting: Use 1 tablespoonful of plant food to 1 gallon of water.

For air-layering: Use 1 tablespoonful to 1 gallon of water. Soak moss thoroughly and squeeze out excess solution before applying moss to plant that is being "mossed off" or air-layered.

For seed-beds: Use 1 teaspoonful to 1 gallon of water. Soak bed well before planting seeds.

Feed seed-beds and cuttings twice a week. Transplanted shrubs, flowers, trees, rosebushes, etc. should be fed once a week to be assured of a strong root system. Feed potted plants once a week, unless they show a need for more plant food.

There are many formulas for growing plants without the benefit of soil. However, the formula developed at Ohio State and recommended by Professor Alex Laurie in his book, *Soilless Culture Simplified*, published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y., has proven very successful for use with gravel culture. To make up ten gallons of single strength solution use the following chemicals:

Ammonium sulfate	4.50 grams
Monocalcium phosphate	11.40 "
Magnesium sulfate	21.60 "
Potassium nitrate	29.90 "

Should you wish to mix the chemicals and keep them dry for making future solutions, add approximately the same weight of gypsum or calcium sul-

fate. Mix thoroughly before storing. The strength of the solution can vary to a wide degree. Ohio State's formula varies from about 110 parts per million (ppm.) single strength for nitrogen to 220 ppm. double strength.

Dr. W. F. Gericke, formerly of the University of California, recommends approximately 165 ppm. of nitrogen, while the Boyce-Thompson Institute formula carries approximately 225 ppm. of nitrogen. Boyce-Thompson uses a little more phosphorous (P_2O_5) than does Ohio State or Purdue, thus producing a splendid root system, while Purdue furnishes the highest ratio of potash K_2O .

The Florida Christian College located at Temple Terrace just outside of Tampa, Florida has installed an acre of concrete beds, using gravel as a support for their plants. This installation has proven very successful to the College and is supervised by Mr. R. J. Browne who is assisted by the College students. It is known and recognized to be the largest hydroponic installation of its kind on the west coast of Florida. Their estimated return on tomatoes last year was \$15,000.00. The formula they use has been developed by me, and I will gladly send to any school or college, free of charge, enough material to make up 50 gallons of solution. It has an approximate 1-1-2 ratio of nitrogen, phosphorus, and potassium with all known minor elements included. Just write to Dr. Paul Chatelier, c/o Chatelier Plant Food, Post Office Box 119-Station A, St. Petersburg, Florida.

UNCLE SAM WILL SEND IT . . . if you order directly from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Send payment (cash, check, or money order) with order.

BOOKS, BOOKLETS, BULLETINS ON SOIL AND WATER CONSERVATION. A bibliography. Cat.: A 1.75:63/2. 15 cents.

ALASKA'S FISH AND WILDLIFE. Cat.: I 49.4:17. 25 cents.

LABORATORY EXPERIMENTS WITH RADIOISOTOPES FOR HIGH SCHOOL DEMONSTRATIONS. A booklet of 20 experiments. Cat.: Y 3.At 7:2 R 11/18. 25 cents.

FROM HAND TO MOUTH. A brief account of what you can and must do to prevent the spread of disease. Cat.: FS 2.35:3/3. 20 cents.

LOOK AND LIVE! Suggestions reminding one of the basic fundamentals of flying. Cat.: C 31.102:L 87. 15 cents.

TEACHING AS A CAREER. FS 5.3:947/11. 15 cents.

ATTRACTING BIRDS. Cat.: I 1.72:1/2. 10 cents.

A NATIONAL SERVICE

**ALBERT
TEACHERS
AGENCY
and COLLEGE
BUREAU**

Efficient, reliable and personalized service for teachers and schools. Under direct Albert management for three generations.

**Original Albert
Since 1885**

Member NATA

25 E. JACKSON BLVD., CHICAGO 4, ILL.



NORBERT J. SCULLY, Senior Plant Physiologist, Division of Biological and Medical Research, Argonne National Laboratory, Lemont, Illinois. Participant in Friday afternoon, April 2, session on Reports on Research in Science: "The Biosynthesis of Radioactive Forms of Biological Compounds."

ARGONNE NATIONAL LABORATORY PHOTO



FLETCHER G. WATSON, Associate Professor of Education, Graduate School of Education, Harvard University, Cambridge, Massachusetts. Participant in Friday morning, April 2, symposium on "A Look At Science Education Today"; chairman of discussion group 17, critical issues in science education.

HARVARD NEWS PHOTO

ROBERT STOLLBERG, Associate Professor of Science and Education, San Francisco State College, California. Principal speaker, elementary science general session, Friday morning, April 2: "The Precious Gem in Science Teaching"; participant in elementary science "Here's How I Do It" session, Saturday afternoon, April 3; chairman of discussion group 1 on planning the K-12 program in science.

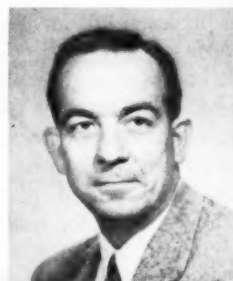


PHOTO BY STAGGS

HARLAN HATCHER, President, University of Michigan, Ann Arbor. Will deliver convention keynote address at general session, Thursday afternoon, April 1: "Science in General Education."



PHOTO BY RENTSCHLERS STUDIO



SAMUEL K. ALLISON, Professor of Physics and Director of the Institute for Nuclear Studies, University of Chicago. Participant in Friday afternoon, April 2, session on Reports on Research in Science: "Present Status of High Energy Research."

UNIVERSITY OF CHICAGO PHOTO



N. ELDRED BINGHAM, Professor of Education, University of Florida, Gainesville. Participant in elementary science clinic, Saturday morning, April 3; consultant to discussion group 19.



WALTER S. LAPP, Overbrook High School, Philadelphia, Pennsylvania. President-elect of NSTA; chairman of general session, Saturday morning, April 3.

S. RALPH POWERS, Professor Emeritus of Natural Sciences, Teachers College, Columbia University, New York City. Chairman of discussion group 19, dealing with the improvement of services to science teachers offered through professional journals.



HIGH

C
H
I
C
A
G
O

ole

N S

14

naha

CONWT

HIGHTS



JOHN S. RICHARDSON, Professor of Education, Ohio State University, Columbus. Chairman of Advisory Council on Industry-Science Teaching Relations, which meets Wednesday, March 31 and Thursday, April 1; chairman of clinic session on "Facilities for Science Instruction" and discussion group 18 concerning education's cooperation with non-school groups.



PAUL B. SEARS, Professor of Conservation and Director of the Graduate Conservation Education Program, Yale University, New Haven, Connecticut. Principal speaker, general session, Friday morning, April 2: "Appraisal of Natural Resources." Photo by Yale University News Bureau—Alburtus.



FRANCIS C. WARD PHOTO

AGNES E. MEYER, Washington, D. C. Well-known speaker on public affairs and issues. Will deliver address at general session, Saturday morning, April 3: "Science and Society."



FARRINGTON DANIELS, Chairman, Department of Chemistry, University of Wisconsin, Madison. Participant in Friday afternoon, April 2, session on Reports on Research in Science: "Utilization of Solar Energy."



CHEMICAL AND ENGINEERING NEWS PHOTO

ROBERT H. COOPER, Ball State Teachers College, Muncie, Indiana. General chairman of elementary science portions of convention program; presiding at elementary science session Friday morning, April 2.



JAMES A. REYNIERS, Director of the Loebund Institute, University of Notre Dame, Notre Dame, Indiana. Participant in Friday afternoon, April 2, session on Reports on Research in Science: "Life in a Germ-Free Environment."



PHILIP G. JOHNSON, Professor of Science Education, Cornell University, Ithaca, New York. Past-president of NSTA; chairman of NSTA's Future Scientists of America Foundation. Chairman of symposium on "Encouraging Scientific and Engineering Manpower for the Future," Friday morning, April 2; toastmaster at banquet session, Friday evening, April 2.



DETLEV BRONK, President of the National Academy of Sciences, Washington, D. C., and President of the Rockefeller Institute for Medical Research, New York City, will deliver banquet session address, Friday evening, April 2.

A
P
R
I
L

1

G. MARIAN YOUNG, Elementary School, Teachers College, Columbia University, New York City. Participant in symposium on the use of simple equipment in teaching elementary science; chairman of elementary science clinic, Saturday morning, April 3.



194
national

CONVENTION



GORDON E. VAN HOOFT, Bureau of Secondary Curriculum Development, State Department of Education, Albany, New York. Chairman of discussion group 8, next steps in curriculum development for science in general education.



LETHA A. WILLIAMS, Sixth Grade Teacher, Union Elementary School, Connersville, Indiana. Chairman of discussion group 6 on the training in science of elementary teachers.



PHOTO BY PROSPERIAN PRESS

NORMAN R. D. JONES, Chairman of Science Department and Teacher of Biology, Southwest High School, St. Louis, Missouri; Past-president of NSTA; Chairman of Greater St. Louis Science Fair. Chairman of discussion group 21 dealing with motivation through extra-class activities and improved articulation of such programs with the science curriculum.



GARNET TODD, Elementary Science Teacher, Harrison and McKinley Schools, East Chicago, Indiana. Chairman of discussion group 4 concerning the identification of science interests of young children; participant in symposium on the use of simple equipment in teaching elementary science, Friday morning April 2.



REBMAN PHOTO SERVICE

GRACE C. MADDUX, Assistant Supervisor of Science, Cleveland, Ohio, Public Schools. Participant in elementary science clinic, Saturday morning, April 3.



ELRA M. PALMER, Supervisor of Science, Baltimore, Maryland, Public Schools. Chairman of discussion group 10, TV and science instruction.

MURIEL BEUSCHLEIN, Counselor for Student Teachers, Chicago Teachers College, and managing editor *The American Biology Teacher*. Chairman of elementary science "Here's How I Do It" session, Saturday afternoon, April 3.

RALPH W. LEFLER, Assistant Professor of Physics and Education, Purdue University, Lafayette, Indiana. Past-president of NSTA; chairman of convention program committee.

LESTER D. BEERS, Science Coordinator, Plainfield, New Jersey, Public Schools. Chairman of discussion group 13 on improvement of science instruction through more effective efforts of science supervisors, coordinators, and department heads in the smaller school systems.

HERBERT MONTGOMERY, School Camp Director and Elementary Science Consultant, Henry Township School Corporation, New Castle, Indiana. Participant in Friday morning, April 2, symposium on the use of simple equipment in teaching elementary science; chairman of discussion group 3 on locating and using community resources for elementary science.

CHARLOTTE L. GRANT, Dean of Junior Class and Teacher of Biology, Oak Park and River Forest High School, Oak Park, Illinois. President of NSTA; presiding at opening general session, Thursday afternoon, April 1.



PHOTO BY DILL



What Holds the Water Up?

By M. F. VESSEL

Professor of Science Education, San Jose State College, California

PERHAPS the one unique feature of a science course which makes it different from other subject matter courses is the method used in learning science. This method is one of problem solving or the scientific method. Although this is well enough known to all of us, knowing it is not enough. Only by using the scientific method can the beginner appreciate and understand what science is.

The question usually asked is—How do I go about teaching problem solving and the scientific method? Many of us have had intriguing problems develop which might be of interest and help to other teachers. Here is a series of simple exercises which the writer has used successfully a number of times. Perhaps others will find them equally intriguing.

The class may be studying weather factors or air pressure. To set the stage, the instructor is conspicuously busy cleaning an aquarium using a dip tube as the class assembles on this particular day. Some student will usually ask what is going on. The instructor will then reach into a drawer, get some glass tubes (plastic tubes and straws will work), and the class will do the dip tube experiment. Dip one end of the glass tube into water and close the opposite end with a finger. Lift out the tube and water remains in the tube. The student is to explain briefly why this happens.



The usual student explanation for this experiment is "air pressure." The author of a prominent textbook explains it by saying: air is pressing on the lower end but is prohibited by the finger from pressing equally on the upper end.

With a casual comment that the scientist withholds judgment until he is sure, the instructor provides the student with a set of cork borers. These are available in most chemistry and physics laboratories. (If cork borers are not available, different diameters of plastic or glass tubing will serve as well providing the ends are smooth and straight.)

Starting with the smallest tube, the student tries the dip tube experiment with all of the different sizes of tubes. He is also told to observe the water surface at the lower end of the tube and record his explanations.

The question now before the student is: Why does the water persistently run out of the tube if the tube diameter is about one-half an inch or so? A frequent complaint made is that the finger isn't big enough to cover the upper end of the tube so be sure to have a supply of proper sized corks on hand.

Using the same tubes or cork borers the student repeats the experiment using alcohol or kerosene instead of water.

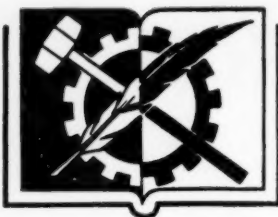
Now he asks: Why can you not hold up alcohol or kerosene in the same size of tube that you can hold up water?

Next, the student takes the largest cork borer—one in which the water could not be held when tested. Partially filling the tube with water he inverts it holding a finger or a cork on the opposite end. Now he places a thin card about one inch square over the open end and carefully turns the tube upright holding the card in place. He gently removes his hand from the card and the water should remain in the tube. Now the student does the common parlor trick using a drinking glass partly filled with water and a card, similar to the experiment just done with the largest tube.



Why can the water be held up in a larger diameter tube if the lower end is sealed off with a card? How does the card effect this experiment?

The inquisitive student is encouraged to try still another experiment using a lamp chimney. The top is sealed off with a cardboard heavily coated with grease. The chimney is now partially filled with water, covered with a card over the open end and gently inverted. Compare this with the drinking glass experiment. While one student is holding the apparatus have another student carefully



THE BEST IN HIGH SCHOOL SCIENCE TEXTS

A 1954 BOOK

PHYSICS—A BASIC SCIENCE

Burns, Verwiebe, Hazel, Van Hooft

3rd Edition

This extremely popular and widely used text has been completely revised, redesigned, and reset. The third edition contains new material to bring the subject matter completely up to date, new problems and questions at topic and chapter ends, new illustrations—both photographs and line drawings. The supplementary material includes a new combination laboratory manual-workbook, new unit tests, and a new teacher's guide.

1953 BOOKS

SCIENCE IN EVERYDAY LIFE

Obourn, Heiss, Montgomery

A new high school general science text that emphasizes learning by doing. Students have the thrill of discovering scientific facts and principles for themselves through the performance of dozens of simple experiments—many of them with a "control" factor introduced to emphasize the scientific method. Supplementary material includes a workbook, a booklet of chapter tests, and teacher's guide.

CHEMISTRY—A COURSE FOR HIGH SCHOOLS

Hogg, Alley, Bickel

3rd Edition

Completely revised, redesigned, and reset. The third edition emphasizes even more than preceding editions the almost limitless applications of chemistry in the modern world. Its organization provides unusual flexibility for adaptation of the course to local needs or class interests. Supplementary material includes a workbook, laboratory manual, unit tests, and teacher's guide.

EARTH SCIENCE—THE WORLD WE LIVE IN

Namowitz, Stone

A new earth science text written specifically for high school students. Its five units, containing thirty-seven short chapters, take up geomorphology, astronomy, meteorology, oceanography, and climatology. The teaching and learning aids at chapter ends are outstanding. Beautifully illustrated. A booklet of tests and a teacher's guide are also available.

ANOTHER FAVORITE

PHYSICAL SCIENCES FOR HIGH SCHOOLS

Hogg, Cross, Little

Written for 11th and 12th grade non-science majors who want to learn the basic facts and principles of the physical sciences to better equip themselves for life in today's scientific world. The interrelationships of the various fields are emphasized, and a too technical and mathematical approach is avoided. Supplementary material includes a workbook, unit tests, and teacher's guide.

D. VAN NOSTRAND COMPANY, INC.

250 Fourth Avenue

New York 3, N. Y.

puncture the greased card with a red-hot needle. Why does the water drop out?

By performing these exercises and guided by a few thought questions, the student is able to appreciate that "air pressure" is only a partial explanation for these experiments. Furthermore, the explanation in textbooks of the dip tube experiment is frequently inadequate or incorrect and this is always a revelation to the beginning student. A factor involved and one seldom mentioned in these experiments is the surface tension of water. This is the surface film of water which provides a body on which the air presses. As the diameter of the tube becomes larger the surface film is stretched and becomes more and more spherical in shape due to gravity and cohesion. Eventually the film rup-

tures and the water runs out. The cardboard in the experiment prevents the water film from assuming a spherical shape. (There is undoubtedly some interaction between the molecules of water and the cardboard also.)

To appreciate the existence of the water film and the toughness of its surface the student is given needles and razor blades which he floats on the water's surface. A more vivid demonstration showing the presence of the water film can be shown with a water strider or water spider. Place the animal in a glass of water. While it is moving about on the surface of the water introduce some soap or detergent and watch what happens. The dependence of these animals on the tough water film will certainly be obvious.

Elementary Science

The School Assembly As A Science Experience

By N. Eldred Bingham

Professor of Education, University of Florida, Gainesville

and Marjorie Bingham

THE LIGHTS went down. The youngsters of the entire school sat in expectant silence as the play was about to begin. Only the fifth-graders were absent from the audience; they were to be the "players." The dittoed program read:

Vacation Fun, or An American Family Goes Camping

CHARACTERS: Mrs. Allen, Mr. Allen, Elizabeth, Tommy, Aunt Beth, Forest Ranger.

SCENE I. *In the Sierra Nevada Mountains, California. A camp at an elevation of 8456 feet. It is near a huge granite boulder overlooking a blue mountain lake. The time is 8 a.m. and the family is coming back from a morning swim—cold but enjoyed by all campers. Mother and Aunt Beth have come on ahead and are preparing breakfast.*

Curtain

TOMMY: "Boy oh boy, was that water cold!"

MOTHER: "That reminds me; will you go bring some drinking water, Tommy?"

AUNT BETH: "And who will volunteer to bring up the wood for a campfire tonight?"

MOTHER: "Elizabeth, will you please get the plates out for our breakfast?"

ELIZABETH: "I am going to get my doll out of the tent."

TOMMY (*bringing in bucket of drinking water*): "Why did you bring that doll on a camping trip? I have to do all the work."

ELIZABETH: "Oh, keep still." (*Argument and small tussle ensues.*)

MOTHER: "Elizabeth! You are old enough to stop these fights. There are lots more interesting things to do than that. Let's think about the things we're going to do today. After breakfast we'll be starting our climb up Mt. Connass. That's a stiff climb—over 12,000 feet."

AUNT BETH: "My, this bacon smells good. Come and get it, everybody! Do you remember the time our bacon caught on fire and we tried to put it out with water? Remember what happened?"

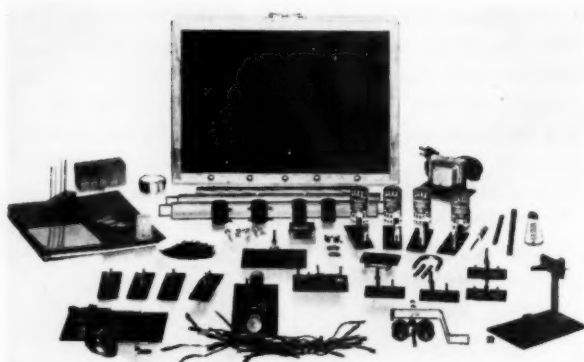
FATHER (*coming in*): "Yes, I remember. I've been thinking about the dangers of campfires in the woods, too. I saw the forest ranger this morning down by the lake and he said he will come over to our camp and tell us about fires—how to put them out and how to protect our forests."

(*All proceed with breakfast and conversation.*)

Forest Ranger comes in. Greets everyone. No-

FOR TEACHING
GENERAL SCIENCE ELECTRICITY

Use the New CROW
Beginner's Experimental Kit



- **SAFE**—Uses only 6 volt D.C. and A.C.; same as flashlight—no possibility of shock.
- **COMPLETE**—Comes with 240 page text-manual containing 319 illustrations.
- **COMPREHENSIVE**—Covers magnetism, circuits, transformers, electrical devices, motors and controls.
- **INEXPENSIVE**—Every school can now afford to offer instruction in electricity!
- **FOR BEGINNERS**—Manual written for elementary students; no mathematics—profusely illustrated.
- **STUDENTS 'LEARN BY DOING'**—Construct their own operating assemblies.
- **PORTABLE**—Can be carried from room to room or issued to students for home study use.

Experiments and assemblies cover:

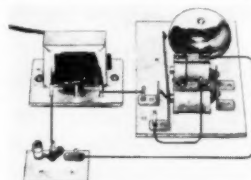
Permanent Magnetism
Electro-Magnetism
Circuitry, switches, fuses
Induction and transformers
D.C. and A.C. electric motors and controls

Bells
Buzzers
Thermostats
Relays

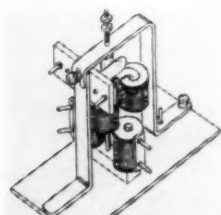
- **PRICE**—Complete with manual, transformer and portable case—\$47.50



Electro-Magnet Experiment



Bell Assembly and Circuit



Sketch of AC Motor Assembly

Write for Illustrated Bulletin

UNIVERSAL SCIENTIFIC CO., INC.

Box 336M

Vincennes, Indiana

tices and compliments them on fine camping equipment—cots, sleeping bags, air mattresses, etc. He accepts "a bite to eat" and tells one or two stories about experiences with bears in camps. He asks if the family is comfortable, cautions them about fires in the forests, and volunteers to do some experiments to help them understand fires and how to be safe with them. As he proceeds with the experiments (described below), he asks questions and ad libs; the children answer and sometimes ask questions also.

Experiments:

1. What is necessary for a fire? By lighting a candle and also a lantern, it is shown that fuel is necessary and that there must be a source of heat to kindle fire.
2. Is air necessary? It is shown that a candle will stop burning when placed under an inverted glass jar. One goes out more quickly under a small jar than a larger one.
3. How does oxygen affect kindling-point temperature? By heating sugar on a hot plate, and then heating a mixture of sugar and potassium chlorate similarly (see precautions that follow), it is shown that an abundant supply of oxygen makes things burn more readily.
4. How did the first matches work? A fire is started by dropping concentrated sulfuric acid on a mixture of sugar and potassium chlorate.
5. How do modern matches kindle? Both ordinary and safety matches are demonstrated and explained.
6. How did people start fires before they had matches? Fire is made by using flint and steel to ignite charred cloth, which in turn lights tissue paper. Why blow on the glowing tinder?
7. How extinguish a gasoline fire? A small gasoline fire is extinguished by "smothering," then by using carbon tetrachloride.
8. How extinguish a grease fire? It is demonstrated that water "explodes" a burning, boiling fat fire; that baking soda or common salt extinguishes it.
9. How does the soda-acid extinguisher work? Vinegar (acid) is added to a solution of baking soda to evolve a gas (carbon dioxide). A match is thrust into the gas and is extinguished.
10. How can one extinguish a candle? Use a snuffer to shut off oxygen supply; blow it out (blow away the gaseous fuel); cool it below the kindling temperature; and put a little water around the wick (solidifying the wax and cutting off fuel supply).

(At end of experiments, the campers ask the ranger to come back that evening for their campfire.)

NARRATOR (while removing scene I and preparing scene II): "It is the custom in many camping areas

for the campers from several camps to gather around a campfire in the evening to sing songs. If anyone in the audience knows any of these songs, please join us as we sing."

SCENE II: *Campfire; low lights. Phonograph is playing folk songs or camp songs. Entire fifth-grade group is gathered around, singing.*

FATHER: "That was quite a climb we had up Mt. Conness, even though we didn't get clear to the top. I hope all of you had as delicious a dinner as we had this evening; ours was canned chicken and vegetables cooked in aluminum foil in hot ashes. Now let's top off the day with a good, loud "hymn sing."

(*All sing two or three songs. Curtains close.*)

* * *

It happened in the J. J. Finley School in Gainesville, Florida. All youngsters are interested in fires, and it was mostly the summer experiences of the children that led to this culminating experience that was presented for the educational benefit of the entire school. Some had seen burned-over land; some had been on summer camp trips; some had been simply "experimenting" as boys and girls are constantly doing. This particular fifth-grade group had been studying soil, rocks, erosion, and soil conservation. Some members of the group had been west and seen the Grand Canyon.

As the group interest seemed to center on fire, the teacher asked the children to bring in five questions each which they considered worthy of study by the class. The questions were collected by a committee and sorted into categories for study. The categories decided upon by the class and a few of the questions in each category are listed below as illustrations of the value judgments reached.

How are fires made?

1. When you build a fire, do you have to have something besides wood?
2. Can you start a fire without matches today?
3. What ways did man use to start fires in the young years (their words)?

Discovery of fire

1. How was fire discovered?
2. How did man make fire without matches?

What are the characteristics of fire?

1. Is fire as hot as lava?
2. What is the color of the hottest fire?
3. What keeps a fire going once it gets hot?

Uses of fire and fire safety

1. What are some of the important uses of fire?
2. What did the Indians use fire for?
3. What would you do if your house caught on fire?

Fire extinguishers and putting out fires

1. What is a good chemical for putting out fires?
2. Is water good for putting out all fires?
3. Is sand good for putting out fires?
4. Is it hard to make a fire extinguisher?

Matches

1. What chemicals are in the head of a match?
2. How are safety matches different from regular matches?

Extra questions

1. What chemicals make a fire green or red?
2. What temperature does it take to melt rock?

To begin the study of these questions, each child set about finding anything he could with regard to any of the questions in the list. They used elementary science textbooks, library books, encyclopedias, magazine articles, and other sources. They shared their findings via the bulletin board, discussion periods, and doing experiments.

The class decided to invite a high school science teacher to come in their room and demonstrate some "bigger" experiments. They told him what they had been doing, and he planned his experiments accordingly. They so enjoyed the demonstrations that they decided to put on an assembly for the entire school and to invite the science teacher to repeat his experiments as a forest ranger instructing them on how to use fires safely when camping.

Class committees were organized to plan for the assembly. The scenery committee painted granite rocks, shrubbery, trees, a waterfall, and finally on the last day procured real, live foliage for the two tallest trees. The Florida committee prepared a huge map of the state which showed all of the camping sites now available. This was prepared to stimulate family camping in their own state.

During the assembly all care was taken to be ready in case of accidental fire. A fire extinguisher was on the stage; also a pail of sand. The materials for the experiments with potassium chlorate and sugar were carefully mixed and safely stored until ready for use. Sheets of metal covered the table tops and asbestos pads were used with many of the experiments.

The entire experience was considered by the teachers to be exceptionally rich in desirable educational influences. It provided for direct learnings about fire and fire safety; it provided for group planning and execution of ideas; it spurred interest and enthusiasm for a wholesome and wise use of natural recreational areas; it provided for team work between elementary and high school; it provided for the activities of one class to stimulate an entire school.

Trends IN SCIENCE EDUCATION—1953

By STANLEY B. BROWN

Assistant Professor of Education, University of Colorado, Boulder

A RECOGNITION of the expanding role of science in the lives of all Americans is forcing our schools to re-examine our entire science education program. We are living in an environment so influenced by discoveries and inventions that the need for a fuller understanding and appreciation of the basic principles and potentialities of science is increasingly paramount and evident. This mobile and changing area demands a constant revision and adaptation of both content and method. Likewise, it becomes increasingly important that our youth attain a certain proficiency in the scientific approach to thinking, investigating, and studying.

Change in education is always a slow process. Sometimes it is difficult to weigh and measure trends within the field because of this slow adaptation to the needs of youth. Practices vary from community to community and only after a selective trial and error method are changes adopted. Even then, their acceptance is never universal. This fact makes it difficult to isolate permanent trends in education. The very nature of our democratic effort to provide an education for all American Youth has accented the practical, functional approach. Consequently certain trends in the teaching of science seem obvious enough when we carefully scan what is being done in an ever-increasing number of schools.

Trends in course-of-study reorganization toward:

1. A continuous, integrated, 12-year program of science planned for general education.
2. An elementary school science which is not a watered-down mixture of high school biology, physics, and chemistry but an exploration of the problems existing in the natural environment of the child.
3. The replacement of the traditional nature study by a broader, more functional, and coherent program of science which includes more physical science than formerly.
4. Offering integrated courses such as general science and general biology as required courses in the 9th and 10th grades, respectively, in order to reach as many pupils as possible before they are eliminated.
5. Offering general physical science in the 11th

- or 12th grade as an elective course, providing both general and propaedeutic education.
6. Offering survey courses in the biological and physical sciences on the junior college level; offered for general education along with pre-technical specialized courses.
7. Enrichment of the science curriculum by means of additional elective courses appropriate for the resources of the community; size and facilities of the school; needs and interests of its pupils.
8. Less college domination of the science curriculum with a more proportionate concern for the needs and interests of the noncollege-preparatory group.
9. Higher enrollments in general science, biology, and physical science, but lower enrollments in physics and chemistry.
10. Increased emphasis on science as an integral part of the school program—either as a separate course or in combination with social studies or some other area.
11. Development of course outlines by school systems and publishers to insure a sequence of subject matter from the kindergarten through senior high school.
12. More atomic energy materials in the various science courses to help youth meet the problems and challenges brought into being by the atomic-air age.
13. Requiring more science courses for graduation (secondary and higher education level).
14. The kind of science course which is as applicable for the small high school as for the large high school, eliminating many of the more technical and more expensive courses found only in large high schools.
15. Science courses designed for all youth—the slow learner as well as the rapidly-maturing individual—rather than exclusively for the student who plans to continue his study of science.
16. The determination of curriculum content after community surveys have been made and an inventory compiled of those phases of community life pertaining to science.
17. The study of the application of scientific principles in the home, on the farm, in the industries of the community, and as related to the health, safety, sanitation, transportation and communication of the community.

18. Science texts which are less college preparatory and encyclopedic but are more functional in the every day life of students.
19. Science texts authored by teams instead of individuals—teams often made up of a high school science teacher, a science subject matter specialist, and a science educator engaged in teacher training.
20. Texts utilizing a psychological organization of content instead of the logical arrangement of subject matter.
21. The concept of a changing curriculum and changing curricular materials to keep step with changing communities, changing young people, and changing knowledge.

Trends in methodology toward:

1. Giving attention to objectives which lead to modification of behavior as well as the objective of the acquisition of facts.
2. Science experiences and units built around the solving of real, meaningful, and socially significant problems—the solution of which involves materials from several subject matter fields.
3. More cooperative planning; administrators, teachers, and pupils planning and working together to execute an effective science program.
4. Greater utilization of community resources; for example, studying the birds of Middletown

instead of the exotic birds of Pakistan.

5. Seasonal organization of subject matter; for example, studying the birds which are native to the community and when they are present in the community.
6. Covering less material well—instead of covering all the material provided in the text.
7. Fitting and adapting science offerings, methods, and content to the needs, interests, and abilities of boys and girls instead of to the interest of scientists.
8. Greater use of problem methods, activity programs, supervised study, unit plans, project methods, socialized groups, A-V materials, and home-made equipment.
9. The use of a wider range of materials and more extensive reading programs—several texts, periodicals, and newspapers instead of a single text.
10. The organization of science clubs as a means of enriching the regular courses.
11. Elimination of the double laboratory period.
12. More demonstration and lecture-demonstration with less individual laboratory work.
13. A study of the most efficient techniques of demonstrating scientific laws and principles.
14. Combination classroom and laboratory instead of different rooms and different days for class-work and laboratory.
15. Use of prepared diagrams and away from detailed, artistic drawings made by students.
16. Use of actual experiences, more doing, and less reading and hearing about science.
17. Use of a more practical laboratory manual; toward less filling-in of blanks and less experimentation on a cook-book basis.
18. The use of the laboratory as a method of instruction whenever it is appropriate and needed instead of being conducted on set days.
19. Individualization of experiments on the basis of the student's unique interests.
20. Development of experiments by means of group cooperation on the part of the students.
21. A realization that there is no one best way but that all methodology has a part to play in modern science education.
22. An increased emphasis on the importance of problem recognition followed by individual and group usage of the basic steps of the scientific method of thought and experimentation for solution of those problems.

These trends were compiled through a study of recent and current issues of leading science education periodicals; a survey of the various yearbooks in the field; an investigation of reports of various committees studying the problems of modern science education; an analysis of the opinions of experts in science education; and through an examination of recently published textbooks in the field of science.



A NEW EDITION OF AN OLD FAVORITE

OUR SURROUNDINGS

by
**Fowler, Collister
and Thurston**

This latest edition (copyright 1953) of a popular textbook in General Science is written expressly for use either as the top book of a three-year course, or for schools that require a one-year course in General Science. The simplicity and clarity of its language, as well as the completeness of its coverage, make it outstanding as a classroom text. Other unusual features are brief biographies of famous scientists, and a glossary of 1100 basic scientific terms. Beautifully illustrated with a profusion of photographs and diagrams.

IROQUOIS PUBLISHING COMPANY, INC.

Home Office: Iroquois Building
P. O. Box 1315, Syracuse, New York
New York Chicago Atlanta Dallas

Presenting

Nominees for & Directors

The following biographical sketches include, in this order: name; present professional connection; degrees, publications, and special honors; NSTA and other professional activities; family and hobby interests. See also "NSTA Activities" page 91 of this issue.

For President-Elect

ROBERT STOLLBERG. Associate Professor of Science and Education, San Francisco State College, California. BS (physics), BEd, University of Toledo, MA, EdD, Columbia University; dozens of articles on science, electronics, and science education in several different journals; laboratory manuals, instructional booklets and materials included patented equipment for teaching elementary and secondary school science; Phi Delta Kappa; Chairman of NSTA committee that produced "Science In Secondary Schools Today," *Bulletin* of the National Association of Secondary School Principals; member of NSTA Board of Directors; member NSTA elementary school science committee; member NSTA committee on standards for certification of science teachers; member NARST; president of Elementary School Science Association of Northern California; member of Board of Directors, California Science Teachers Association (Northern Section); member Conference on Nation-Wide Problems of Science Teaching at Harvard University, summer of 1953. Married; two daughters; two sons; electronics, travel-camping, music.

STANLEY E. WILLIAMSON. Head of Department of Science Education and Director of Student Teaching, Oregon State College, Corvallis. BA, Nebraska Wesleyan University, MA, Columbia University, EdD (nearing completion), University of Oregon; several articles on science and education in University of Oregon curriculum bulletins; Phi Delta Kappa, Kappa Delta Pi. Member NSTA Board of Directors since 1949; western regional vice-president 1953-55; chairman NSTA workshop committee on science education in civil defense; member Oregon Alcohol Education Committee and Oregon Committee on Conservation; member Executive Committee, Oregon Association of Secondary School Principals. Married; two sons, one daughter; photography, camping, fishing; President Corvallis Lions Club, 1953-54.



ROBERT STOLLBERG



GRETA OPPE



DOROTHY TRYON

JOHN S. RICHARDSON



ELRA M. PALMER



STANLEY E. WILLIAMSON



For Secretary

GRETA OPPE. Head of science department and teacher of chemistry, Ball High School, Galveston, Texas. BA, University of Texas, MA, New York University, other graduate work, Harvard University, Syracuse University, and University of Michigan. Contributor to *Journal of Chemical Education*, *Biological Abstracts*, and *Metropolitan Detroit Science Review*; author of *Chemistry—A Worktext for High Schools* (Steck Co.); Fellow of AAAS and NEA representative on AAAS Council; Life Fellow of Texas Academy of Science; Life Member of NEA, NSTA, and Texas Association of Science Teachers. Long-time member NSTA Board of Directors; southern regional vice-president 1953-55. Interested in religious education.

DOROTHY TRYON. Head of science department and teacher of biology and chemistry, Redford High School, Detroit, Michigan. BS (chemistry), MS (chemistry), Wayne University; articles on science and science education in *Metropolitan Detroit Science Review*. Serving second of two terms on NSTA Board of Directors; member NSTA workshop committee on science education in civil defense; chairman of summer regional conference at University of Michigan, 1952; Past president of Metropolitan Detroit Science Club; active

CALVIN GRASS



RALPH E. KEIRSTEAD



CHARLES G. GARDNER



CHIDNOFF STUDIO

Officers for 1954-55



RUTH TRYON SCHENBERG



HENRY F. WHITE

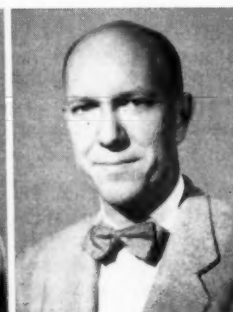


OTIS W. ALLEN

Y. E. WILLIAMS ARMSTRONG

WILLIAM T. WILKS

MERTEN M. HASSE



in NABT, AAAS, local section of American Chemical Society, and local NEA group. Hobbies: photography, gardening, travel, reading "who-dun-its."

For Treasurer

ELRA M. PALMER. Supervisor of Science, High Schools, Baltimore, Maryland. BS, MEd, Johns Hopkins University; numerous articles in *Baltimore Bulletin of Education*, *The Maryland Naturalist*, *The Maryland Conservationist*, *The Baltimore Sun*; Phi Delta Kappa. Member NSTA Board of Directors, 1950-52, eastern regional vice-president, 1953-55; secretary of NSTA workshop committee on science education in civil defense; region III chairman for NSTA's Future Scientists of America Foundation Science Achievement Awards for Students, 1954; member Conference on Nation-Wide Problems of Science Teaching at Harvard University, summer of 1953; past president Maryland Science Teachers Association; trustee and educational director The Natural History Society of Maryland. Married; two daughters; geology and paleontology of Maryland; president of residential community association.

JOHN S. RICHARDSON. Professor of Education, Ohio State University. BSEd, MA, Miami University, PhD,



LOUIS H. DUNLOP



STONE STUDIO

MARIAN YOUNG



HAROLD HAINFELD

Ohio State University; co-author of *Methods and Materials for Teaching General and Physical Science* (McGraw-Hill Book Co.); author of many magazine articles on science teaching; Phi Beta Kappa, Phi Delta Kappa. NSTA treasurer, 1953-54; chairman of NSTA Advisory Council on Industry-Science Teaching Relations, 1952-54; secretary of committee and editor of report of NSTA research study on *School Facilities for Science Teaching*; member of Administrative Committee of NSTA's Future Scientists of America Foundation. Married; two sons, one daughter; woodworking, travel.

For Alternate Director, Region I (One-year term)

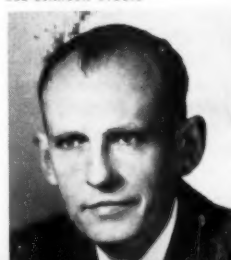
CALVIN F. GRASS. Head of science department, Lancaster, New Hampshire, High School. AB, Boston University, MEd (nearing completion), University of Maine; Westinghouse Fellow at Carnegie Institute of Technology, summer of 1953. President of North Country Science Teachers Association; co-chairman of North Country Science Fair and member of committee for N. H. State Science Fair. Married; two sons; photography, electronics, music.

RALPH E. KEIRSTEAD. Consultant in Science, Hartford, Conn., Public Schools. AB, Bowdoin College, EdM, Bates College; co-author *Wonderworld of Science* series (Scribners) and *Science for a Better World* (Scribners); Phi Beta Kappa; Fellow, Fund for the Advancement of Education of the Ford Foundation, 1952-53. Member of NSTA evaluation committee for the Packet Service; past president New England Association of Chemistry Teachers; director, Connecticut Science Teachers Association. Married; one son; woodworking, gardening, Civitan Club.

For Director and Alternate Director, Region II (Two-year terms)

LOUIS H. DUNLOP. Chairman of department of science and chemistry instructor, McKeesport, Pa., High School. BS, Allegheny College, MEd, University of Pittsburgh. Member of committee on local arrangements for Pittsburgh national convention of NSTA; area director; member American Chemical Society. Married; woodcraft and photography.

J. DONALD HENDERSON
LEE-EVANSON STUDIO



ROBERT MOLKENBUR



GLENN E. WARNEKING



CHARLES G. GARDNER. General science teacher, Grant Junior High School, Syracuse, N. Y. AB, MS, Syracuse University. NSTA state director for New York; president of New York State Teachers Association; organized Central New York Science Congress (1949) and has been director for six years. Married; one son; Boy Scouts, church activities; hiking and camping; photography; science clubs and congresses.

HAROLD HAINFELD. Science teacher, Roosevelt Elementary School, Union City, New Jersey. BS, MA, New York University, Professional Diploma (32 points beyond MA), Columbia University; many articles on military subjects, science teaching, and radio and TV in various magazines; in military service 1942-46; 1st Lieut. and instructor, Chemical Warfare Service; received awards from American Museum of Natural History and Chicago Radio Council for classroom utilization of radio; Phi Delta Kappa, Kappa Phi Kappa. Vice-president, New Jersey Science Teachers Association; president, New Jersey Association for Education by Radio-Television; editor, New Jersey Audio-Visual Council *Newsletter*. Married; one daughter, twin boys; photography, stamp collecting.

SAMUEL SCHENBERG. Supervisor of Science, High School Division, New York City Public Schools. BSChE, Massachusetts Institute of Technology, MA, New York University, LLB, Brooklyn Law School; articles in *Journal of Chemical Education*, *The Science Teacher*, *The Teaching Scientist*, and other magazines; editor of *Use of Radioisotopes in High School Science Teaching* produced by Atomic Energy Commission. NSTA area director for New York City and vicinity; past president Chemistry Teachers Club of New York City; member ACS and NARST; consultant to Oil Information Committee of American Petroleum Institute. Married; one daughter; bridge and golf.

HENRY F. WHITE. Chairman, Science Department, School of Education, Fordham University, New York City. AB, Fordham College, MA, Villanova College, PhD, Fordham University; syllabi in chemistry, biology, and general science (in preparation), Archdiocese of New York. Member School Health Advisory Committee of N. Y.; Tuberculosis and Health Association; president New York Chapter of National Catholic Round Table of Science; member of Executive Committee, Archdiocesan Science Council of New York. Married; two daughters, one son.

MARIAN YOUNG. Elementary classroom teacher, New York City; summers, Visiting Professor, University of Arkansas. BS, MA and Professional Diploma, EdD, Columbia University. Author of numerous science articles, film scripts, and books (in preparation) for children; honorary member Eugene Field Society. Second vice president 1952-53, secretary-treasurer 1953-54 of National Council for Elementary Science; active in Association for Childhood Education. Interests are travel and writing.

For Director and Alternate Director, Region IV (Two-year terms)

OTIS W. ALLEN. Head of science department, Greenwood, Mississippi, High School. BS, Western Kentucky College, MS, Ohio State University; composed and delivered more than one hundred speeches on science and science education for civic and professional groups; Fel-

low, Fund for the Advancement of Education of the Ford Foundation 1952-53; writes daily newspaper feature on "What's Right With Greenwood"; received 1946 "Outstanding Young Man" award of Greenwood Junior Chamber of Commerce. Represented NSTA in addressing Relations With Industry Section of American Society for Engineering Education, Gainesville, Fla., June, 1953; regional chairman of NSTA's Science Achievement Awards program; past president of Science Section of Mississippi Education Association; life member of NSTA. Married; three daughters, one son; 16mm movies, offset printing, writing children's science stories.

RUTH ARMSTRONG. Teacher of ninth-grade general science, Fort Smith, Arkansas, Junior High School. BS, MS, University of Arkansas, postgraduate work at University of Chicago and University of Colorado. Member of U. S. Army Educational Mission to Korea, 1948; president of Department of Classroom Teachers of Arkansas Education Association; president of Science Section of Arkansas Education Association; president of Fort Smith Audubon Society. Interested in natural history.

CLYDE T. REED. Head of department of biology, University of Tampa, Florida. AB, BP, Campbell College, MS (zoology), Washington College, MS (entomology), Cornell University; published *Marine Life of Texas Waters*, also many articles in various journals, laboratory manuals in several fields of biology; Life Fellow of Texas Academy of Science; Fellow of AAAS. NSTA representative for state of Florida; organized Texas Academy of Science; active member Florida Association of Science Teachers. Married; field work and photography.

WILLIAM T. WILKS. Professor of Science, State Teachers College, Troy, Alabama. EdD, Columbia University, BS, MS, Alabama Polytechnic Institute; published articles in *Journal of Chemical Education*, *The Science Teacher*, *The Grade Teacher*, *Journal of the Alabama Academy of Science*; Phi Delta Kappa, Kappa Delta Pi. President-Elect of Alabama Academy of Science; past president of Science Division of Alabama Education Association; member AAAS, NARST, NEA, American Association of Physics Teachers. Married; one daughter; bridge and golf.

For Director and Alternate Director, Region VI (Two-year terms)

MERTEN M. HASSE. Head of science department, Central High School, Aberdeen, South Dakota. BA (mathematics and physics), MA (astronomy), Carleton College, further graduate work at State University of Iowa, University of South Dakota, and University of Minnesota; courses of study; "A Science Classroom-Laboratory" in *American School Board Journal*; received Recognition Certificate (for science teaching) of South Dakota School of Mines, 1953; Fellow of Fund for the Advancement of Education of the Ford Foundation, 1953-54; served in U. S. Navy (electronics) 1943-46. Delegate to NSTA's Pittsburgh convention, 1953; past president of Science Roundtable of South Dakota Education Association. Married; six children; active radio amateur for thirty years; operates own radio station and sponsors high school Radio Club with its own station.

J. DONALD HENDERSON. Associate Professor of Physics, University of North Dakota, Grand Forks. BSEd, MS, University of North Dakota, doctoral studies at University of Minnesota; *Course Outline for Physics in North Dakota High Schools*; co-author of *General Physics Laboratory Manual* (Burgess Publishing Co.); articles in other magazines; Phi Delta Kappa, Sigma Xi. NSTA state director for North Dakota; regional chairman of NSTA's Science Achievement Awards program; secretary of North Dakota Academy of Science since 1950 and secretary of committee for *Proceedings* of the Academy; past-president North Dakota chapter of American Association of University Professors. Married; two daughters.

ROBERT MOLKENBUR. Chemistry teacher, Central High School, St. Paul, Minnesota. BA, Macalaster College, MA, University of Minnesota; articles published in *Journal of Minnesota Education Association* and

Proceedings of Minnesota Academy of Science. NSTA state director for Minnesota, member of committee on affiliated groups, Packet Service evaluator; past-president of Minnesota Junior Academy of Science and Physical Science Section of Minnesota Education Association; member of manpower committee of Minnesota Section of American Chemical Society. Married; one daughter, two sons; traveling to places of historical interest; works summers for Minnesota Mining and Manufacturing Company.

GLENN E. WARNEKING. Science teacher, Blair, Nebraska, High School. BA, Nebraska Wesleyan University, ME (nearing completion), University of Nebraska. NSTA state director for Nebraska; chairman Nebraska Junior Academy of Science, 1952-53; delegate to NSTA's Pittsburgh convention and Rocky Mountain Regional Conference at University of Colorado, 1953. Married; radio and electricity, aquaria and terraria.

NSTA Activities

► Report of Nominating Committee

The work of your present nominating committee is finished. Now it's up to you—please mark your ballot and mail it to me not later than March 22.

The nominees for officers and directors of the Association for 1954-55 are presented on pages 88-91. In line with the directive of the Board of Directors (Miami Beach meeting, 1953), two or more candidates have been presented for each position to be filled. These nominees have been selected through the following procedures: (1) suggestions received from members of NSTA; (2) suggestions received from NSTA affiliated groups; (3) suggestions received from NSTA state and area directors; (4) suggestions received from the present Board of Directors and Past Presidents of NSTA. These steps resulted in a list of nearly 200 individuals, from which the nominees were selected in an all-day session of the nominating committee held in New York City last December 19.

I wish to express the thanks and appreciation of the committee to all who have shared in the development of this list of candidates. Our special thanks go to those who have accepted a position among the nominees. My personal acknowledgment of a professional job well done is extended to the following members of the committee: Gladys V. Benner, Philadelphia, Pennsylvania; Hubert Evans, New York City; Helen E. Hale, Towson, Maryland; and Nathan A. Neal, East Orange, New Jersey.

RICHARD H. LAPE, *Chairman*
Amherst Central High School
Snyder, New York

► Obourn Goes to UNESCO



HOWARD EARL DAY PHOTO

Not exactly an NSTA activity, but a high honor for an NSTA member which we're proud to announce. Dr. Ellsworth S. Obourn of the John Burroughs School, Clayton, Missouri, has been named to take charge of Unesco's program for the study of science education and the improvement of science teaching in the member states of Unesco.

This new Unesco post has been established in recognition of the fact that a primary need of the underdeveloped countries is the increased use of science in agriculture and industry. This has created a universal demand for the expansion of science instruction in the schools. In many countries it has been non-existent, except for university training, and Unesco's first emphasis is on the improvement of science teaching in the primary schools, especially in those countries where 99 per cent of the children do not go beyond fifth or sixth grade.

Dr. Obourn is well known throughout the science education fraternity in this country and beyond. He has published textbooks for high school science (the latest being *Science in Everyday Life*, Van Nostrand, 1953) as well as books of methods of teaching science. He is the author of a long list of special articles in educational

publications on the problems and methods of science teaching. Also, he has been active in several organizations for science teachers, notably the National Association for Research in Science Teaching which he served as secretary for ten years. He has served as a member of the Board of Directors of NSTA and is currently a member of the Committee on International Relations.

Dr. Obourn goes into his new post fortified by considerable experience with science teaching in other countries. He has already served as technical expert and advisor to the Ministry of Education at Bangkok in Thailand during 1952 and 1953 (see *The Science Teacher*, February, 1952, p. 34). His principal work will be in connection with Unesco's efforts to help to organize science teachers' associations in various countries and to continue the study of curricula in science teaching throughout the world.

NSTA extends congratulations and best wishes to "Bud" Obourn and expresses the willingness, the eagerness, of our Association to help him in his new work in every way that we can.

Stollberg—continued from page 64

there is roughly one television receiver for every six men, women, and children in the Nation. And on the other hand, there are more radio receivers than ever! In all fairness, of course, some of the early prognosticators were right—and some of them are right today. The question is, "Which ones?"

However, it is possible to draw certain sober probabilities from the current crop of predictions. Among them:

- a. Color TV receivers will be expensive (perhaps \$700-\$1200), particularly at first. They are more complicated, and they include a still high-priced multichrome picture tube. Furthermore, the industry is not yet tooled up for mass production. With improvements and quantity manufacture, the price may in a few years come to within 25-50% of that of today's monochrome receivers of similar quality. (Monochrome prices will probably continue to decline.)
- b. Multichrome receivers will be hard to get—even if one has the price. With increasing production, of course, this situation will be alleviated in a year or two.
- c. Color TV will not die for lack of support. Collectively, the TV networks and producers will invest scores of millions of dollars into this field within the next few years. This will help develop improved multichrome techniques and an expanded multichrome market.
- d. TV programs—both monochrome and multichrome—can now be recorded entirely on magnetic tape. The flexibility and economy which this development promises may markedly affect the pattern of TV in the future. Tape recorded audio and video

may one day do much of what is now done on sound-motion-picture film.

- e. Color TV will not eliminate monochrome TV. For one thing, it would take many years to make another 30 million sets. For another, many customers acquiring TV will retain their old monochrome unit for a "second" set for den, rumpus room, or cottage. There will for the foreseeable future be plenty of monochrome telecasts for which it is no advantage to have a color receiver. There are many commercial and industrial uses of TV which have absolutely no need for color. Some people will prefer monochrome TV. Remember, color photography has not displaced black and white film!

No one really knows what will happen as time and "the state of the art" unroll along the multichrome magic carpet. New trends and developments are sure to amaze us all—and in a short time high school students may challenge their science teachers with questions about something entirely new and different.

But from the perspective of the immediate past, the advent of color TV in late 1953 appears as a major step forward in means of communication and of science in general. Surely it is a development concerning which science teachers should be alert. It represents one more opportunity for reaching young people in terms of their real interests, and of acquainting them with the nature of science and of the world in which they live.

Bibliography

- | | |
|---------------------|--|
| deForest, Lee | "Color Television—Past, Present, Future"— <i>Radio-Electronics</i> January, 1954, pp. 34-6. |
| Feingold, W. R. | "Color TV"— <i>Radio and Television News</i> —October, 1953, pp. 51 et seq., continued in November, 1953, pp. 99 et seq. |
| Fink, D. G. | "NTSC Color Television Standards"— <i>Electronics</i> —December, 1953, pp. 138-50. |
| Fink, D. G. | <i>Television Engineering</i> 2nd Edition—McGraw-Hill, 1952. |
| Gernsbach, H. | "Color TV Problems"— <i>Radio-Electronics</i> —January, 1954, p. 33. |
| Kiver, M. S. | "Color Television"— <i>Photofact Index</i> —July-August, 1953, pp. 5 et seq. |
| Kiver, M. S. | <i>Television Simplified</i> 3rd Edition—Van Nostrand, 1952. |
| Kronenberg, M. H. | "Color TV—the NTSC System"— <i>Radio-Electronics</i> —November, 1953, pp. 30-32. |
| "Washington Editor" | "Spot Radio News" (column entitled "The Color Age")— <i>Radio and Television News</i> —September, 1953, pp. 16 et seq. |



FSA Activities

► *Science Teacher Recognition Awards:*

1953-1954

Each mail coming into the office during the past few days has brought many packages bearing marks of having been carefully wrapped and hopefully forwarded. Participation in this program has more than doubled over last year. Miss Robertson, who has handled the entries, predicts that the judges will have a real job in picking the four award winners.

Whoever they may turn out to be, four teachers can look forward to a proud and happy award ceremony at the April 2 banquet in connection with the 1954 NSTA Convention.

► *Science Achievement Awards:*

1953-1954

As the end of the school year approaches, many teachers will be looking for ways and means to give students additional recognition for exceptionally good science project work. The Awards program solves this kind of problem.

If students are advised of the rules for the Science Achievement Awards program while they are designing their projects, it is a simple matter for them to prepare an entry in the Awards program without too much trouble.

Entry materials can still be obtained from the Foundation in time to meet the May 15 deadline.

As a reminder to those who may have projects ready to submit, the chairmen of the eight regions are:

Region I. MR. RUSSELL MEINHOLD, Science Department, Rhode Island College of Education, Providence, Rhode Island.

Region II. MR. W. L. DAVIDSON, Thomas Jefferson High School, Elizabeth, New Jersey.

Region III. MR. ELRA M. PALMER, Division of Secondary Education, Department of Education, 2418 St. Paul Street, Baltimore 18, Maryland.

Region IV. MR. OTIS W. ALLEN, Greenwood City Schools, Greenwood, Mississippi.

Region V. MISS VIOLET STRAHLER, Stivers High School, Dayton 5, Ohio.

Region VI. MR. J. DONALD HENDERSON, Depart-

ment of Physics, University of North Dakota, Grand Forks, North Dakota.

Region VII. DR. HERBERT A. SMITH, School of Education, University of Kansas, Lawrence, Kansas.

Region VIII. MR. H. M. LOUDERBACK, The Lewis and Clark High School, Spokane 4, Washington.

The Code Number on each entry card indicates the region to which the Entry and Part 1 of the entry card, and the student data sheet should be sent. Parts 2 and 3 of the entry card should be sent to: Committee on Awards, Future Scientists of America Foundation of the National Science Teachers Association, 1201 Sixteenth Street, N. W., Washington 6, D. C.

► *Summer Work for Teachers:*

"In my judgment, practical experience which gives insight into industrial applications of mathematics and science would, by adding reality and competence, improve the effectiveness of teaching these subjects in American secondary schools."

This quotation from the United States Commissioner of Education, Dr. S. M. Brownell, is featured in a brief brochure that is being mailed to industrial executives who are in position to provide science-related summer jobs for teachers. Send us the addresses of any people to whom you would like to have the brochure sent.

► *The School Science Laboratory:*

We have been assured that money will be available to permit at least 32 science teachers to be brought together for two weeks or so in August to make a study of science laboratory activities.

The fellowships are adequate to cover all expenses and provide modest compensation for the participants' services. Tentative plans call for the fellows to spend several days visiting research laboratories and seeing the tactics and strategy of science in operation. The remaining time will be devoted to examining current and proposed laboratory activities against the background of the abilities, skills, and attitudes reflected by successful research people.

The details of this program will be announced in the April issue. Preliminary information now available:

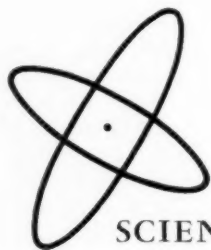
Future Scientists of America Foundation, NSTA
1201 16th St., N. W., Washington 6, D. C.

Now Complete for Grades 7, 8, and 9 . . .

SCIENCE FOR BETTER LIVING

Brandwein—Hollingworth—Beck—Burgess

—Organized to help the teacher take full advantage of
the natural unfolding of a student's interests and curiosity.



YOU AND YOUR WORLD

YOU AND YOUR INHERITANCE

With separate booklets of Teaching Tests

SCIENCE FOR BETTER LIVING: COMPLETE COURSE

With Workbook, Tests, and Visual Aids Booklet

HARCOURT, BRACE AND COMPANY New York 17—Chicago 1

NEW CHARTS

... in full color!

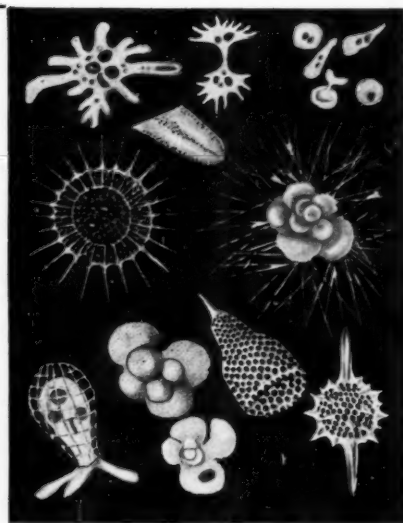


QB6 Wood Anemone

We are pleased to announce republication of the famous JUNG-KOCH-QUENTELL CHARTS. This excellent new series presents its subjects with special techniques and in large size:

34 x 45½ inches

Background color and shading vary through the series, each chosen to enhance the subject portrayed. All the charts are outstanding combinations of beauty and instructional effectiveness.



QZ50 Rhizopoda

**For complete information
write for Circular S41TST**

DENOYER-GEPPERT COMPANY

5245 Ravenswood Avenue

Chicago 40, Illinois

The SCIENCE TEACHER

Classroom Ideas

General Science, Physics

Thermostat Demonstrator

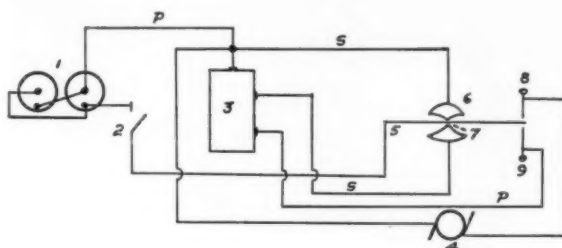
By JENNINGS KING, General Science Teacher
McCormick Junior High School, Cheyenne, Wyoming

The "Jim Hosey" thermostat demonstrator intrigues students and shows the use of a bi-metallic strip as a switch in temperature control.

Jim Hosey, meteorologist with the U. S. Weather Bureau and former science teacher, gave me the rough plans for a thermostat demonstrator he had built. I turned the plans over to five of my ninth-grade students—Larry Marker, Kenneth Scribner, Nikki Breitweiser, Craig Stump, and Kenneth Largent—who adapted the plans to the equipment we had and built the gadget shown in the picture below. Construction details are shown in the drawing. After two years of hard use, including the display and operation at the Western Plains Science Fair, the device still works.

Two 1½-volt dry cells are connected in series to operate two electric circuits. A bi-metallic strip acts as a switch to control operation of both the fan motor and the model T Ford coil. When cold, the bi-metallic strip closes the coil circuit and a hot spark at (7) ignites the alcohol burner. The flame soon causes the bi-metallic strip to bend away, thus opening the coil circuit and stopping the flow of hot sparks to the wick. When the bi-metallic strip bends enough to make contact at (8) the fan operates and blows out the flame and permits the cooling of the bi-metallic strip so that the cycle may be repeated.

The 2-volt DC motor has the fan blades soldered to the armature shaft. The 8½-inch bi-metallic



- | | |
|---------------------|---------------------------------------|
| 1—Dry cells | 6—Divided lamp holder |
| 2—Knife switch | 7—Point of hot spark transfer |
| 3—Model T Ford coil | 8—Contact screw for fan circuit |
| 4—Motor and fan | 9—Contact screw for coil circuit |
| 5—Bi-metallic strip | P—Primary circuit S—Secondary circuit |

strip is made of 18-gauge galvanized iron and aluminum riveted together tightly—a contribution of our metal shop instructor, Mr. D. Frechette. The divided holder for the alcohol lamp is made of lightweight galvanized iron. One side hooks onto metal screw cap of alcohol lamp. The contact screws (8) and (9) may be adjusted so that the bi-metallic strip may have greater or less travel at the free end. The knife switch is used as the master switch.

General Science, Physics

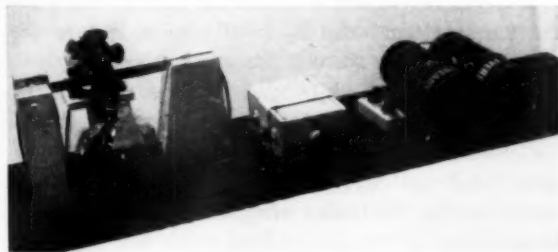
An Electro-Mechanical Television Analogy

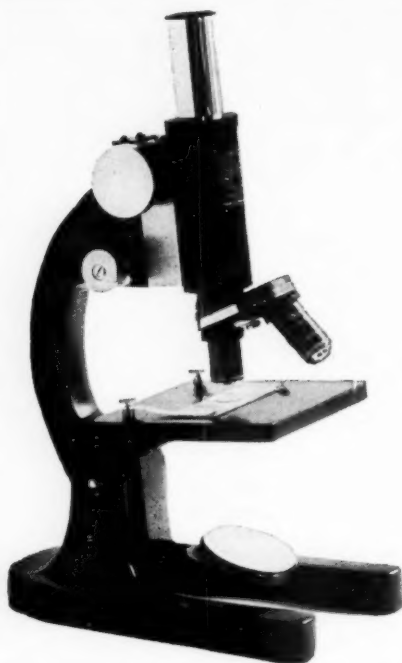
By HARRY MILGROM, Supervisor of Elementary Science
New York City Board of Education, Brooklyn

Do you have difficulty in making clear and understandable the answers to such "television questions" as these?

1. How is the iconoscope image scanned?
2. What is a scanning line?
3. What is interlaced feedback?
4. What is sweepback?
5. How is the image reproduced in the kinescope?
6. What is meant by synchronization?
7. What causes image distortion?

You can make a simple model to answer these questions. Construct the device this way.





Guaranteed for ten years against defective parts or workmanship.

NEW MICROSCOPES

NEWLY DESIGNED

NEW SAFETY FEATURES

The most foolproof microscope on the market. A full sized COMPLETE instrument in the price range of the most reasonable "student" models.

This instrument has:

A FULL fine adjustment
All METAL coarse adjustment rack and pinion
Plano-concave mirror
STANDARD 16mm and 4mm objectives

and an EXCLUSIVE feature of the base extending slightly beyond the objective thereby precluding the bumping of objectives against the back wall of shelves and damaging nosepieces or objectives. Will remain par focal indefinitely.

Mirror specially mounted so it cannot fall out.

Price: \$118.00 (we pay transportation)
Less 10% on 5 or more

Hughenian ocular 10x
Achromatic objectives: 16mm (10x) and 4mm (44x)
Disc diaphragm

Sold on ten days' approval.

Old microscopes accepted in trade.

THE GRAF-APSCO COMPANY
5868 Broadway Chicago 40, Ill.

1. Mount two picture frames (approximately 16 x 14 in.), side by side, on a baseboard to represent the transmitter and receiver image screens.

2. Insert in the left-hand frame (#1 in the diagram) a metal plate of galvanized iron on which is cemented a white cardboard stencil of the picture to be transmitted. This screen represents the iconoscope screen.

3. Place in the right-hand frame (#2) a second metal plate over which is tightly stretched a piece of white sheeting. This screen represents the kinescope screen.

4. Between the two screens and about half an inch in front of them, mount two quarter-inch rods of brass or dowling vertically (#3 in the diagram).

5. Make part #4 by soldering together lengths

of brass tubing, such as curtain rod tubing with an inside diameter of 9/32 in., to form a rectangle. Adjust the spacing of #4 so that it does not move too freely up and down the vertical rods (#3).

6. Place a 3-foot length of quarter-inch dowel through the lower brass tube so that it is free to move horizontally (#5). Drill the dowel at points marked "X" to accommodate the electrodes.

7. Attach two copper electrodes made of #12 wire and bent into loops for contact with corresponding portions of the two screens (#6A and #6B).

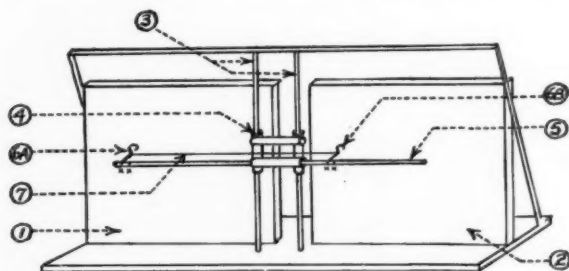
8. Connect the two electrodes with an insulated copper wire running between them outside the tube (#7).

To operate the model in order to answer the questions, proceed as follows.

1. Connect the back of screen #1 to the positive terminal and the back of screen #2 to the negative side of a six-volt storage battery.

2. Dampen the white sheeting over screen #2 with a concentrated solution of potassium iodide.

3. Lift the rectangle (#4) to the highest point, move the dowel (#5) to the extreme left, and twist it so that the electrodes are pressed firmly against the screens.



A Model Television System

4. Pull the dowel slowly to the right. The circuit is completed every time electrode #6A touches the metal plate through the open work of the stencil. On screen #2, Electrode #6B deposits iodine lines in accordance with the stencil pattern. This action produces one scanning line.

5. Move the dowel to the left with electrodes turned off the screens. This represents sweepback.

6. Lower the rectangle (#5) slightly and repeat the scanning action. Do this until the entire stencil image is reproduced on the receiver screen.

7. Scan alternate regions and come back to fill in, to show significance of interlacing.

8. Change alignment of the electrodes so that they do not touch corresponding points on the two screens, to show image distortion.

It should be noted that in this analogy, current flows when dark portions of the stencil are scanned, producing equivalent dark (iodine) image spots on the receiver screen. In actual television operation the reverse, of course, is true.

Physics, General Science

How to Make a Carbon Microphone Using a Telephone Speaker

By CHARLES F. BECK, Science Department, Bristol High School, Bristol, Pennsylvania

In the teaching of units on sound in various science courses, the telephone speaker for voice transmission is of general interest. Its main parts are the diaphragm and carbon granule box. The carbon granule box in the electrical circuit changes the physical energy of the human voice into electrical energy for transmission. When radio telephones were first developed, the adapted telephone speaker was the first microphone.

You may provide your own public address system at small cost. There is not much more needed than a radio set that is operating and one of the old stand-up type of telephone speakers. These are easily procured from your local telephone company as they are being discarded in place of the modern type French dial phone.

The mouthpiece with the carbon granule box is removed from the telephone stand by taking out the four screws that hold it. Two connections will be seen on the back of the granule box. Connecting wires of lamp cord may be attached to these connections. These wires may be 100 feet long, if desired.

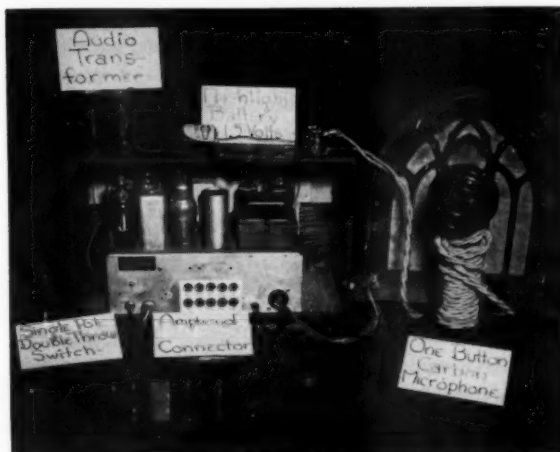


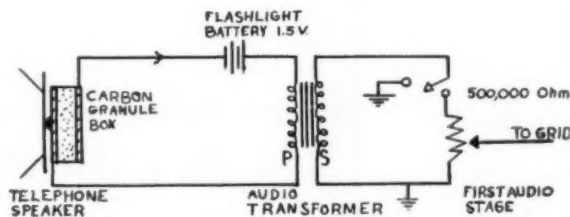
PHOTO BY BERNARD HARTZ, BRISTOL HIGH SCHOOL

No shielding is ordinarily required. A battery of $1\frac{1}{2}$ volts is placed in series in the long microphone wire.

The ends of the two wires should be connected in series to the primary connections of an audio transformer. This is used because the carbon microphone sets up a fluctuating direct current across the secondary. Fasten the audio transformer inside the radio case and the battery on the radio case. Solder all wires to battery and transformer.

Purchase a toggle switch from a radio store, and place it on the back of the radio chassis. Also purchase a screw-in-connection for your microphone wires. Connect the two microphone wires from the secondary of your audio transformer to the screw-in-connection. Make this connection between audio transformer and connector as short as possible to eliminate feedback or else a shielded wire must be used. You are now connected to the chassis.

The toggle switch is necessary in order to allow the radio to be used for ordinary broadcasting as well as for a public address system. Connections inside the set must be made from the switch to the grid of the first stage of audio amplification ahead of the output tube to the speaker. Usually the connection is made to a 500,000 ohm resistance or potentiometer which controls low input to audio



ONE BUTTON CARBON MICROPHONE

amplification stage. A large input lowers the volume of the amplifier. The other connection of the switch goes to the positive of the screw-in-connections. The negative of the screw-in-connector is grounded on the chassis.

The connections inside the chassis may be done by a radio fan. Manufacturers of the radio will send a set diagram and mark the desired places of connections, if requested, or your local radio repair man will make the necessary set connections for a microphone at a nominal cost.

Shielded wire is necessary inside the chassis in order to prevent feedback. Ground the metal shield by soldering to chassis. Older radio sets used the transformer coupling for audio amplification. More modern sets make use of resistance and impedance coupling. Probably resistance coupling in the audio stage is most common in late sets. In all cases the potentiometer or 500,000 ohm resistance is connected through these couplings by shielded wire to the grid of the first audio stage or the output tube.

All you need to produce a powerful public address system is:

An old style stand-up telephone

A radio, any type
An audio transformer—low ratio (1 to 1)
A toggle switch
A screw-on-connector
Lamp cord (any length)
One flashlight battery—1.5 volts

Connections:

Unscrew mouthpiece of telephone speaker
Attach two wires—any desired length
Place flashlight battery in series with wires
Attach wires to primary of audio transformer
Attach audio transformer inside set if possible, or on top of cabinet

Inside set:

Attach connector to back of radio chassis
Attach toggle switch about one inch from screw-on-connector on chassis
Connect two wires from secondary of audio transformer to ground and positive of screw-on-connector
Attach positive of connector to positive of toggle switch by condenser
Attach two wires from toggle switch to potentiometer, using shielded cable

lippincott

revised

texts

for

1954 . . .

See

them

at

the

N.S.T.A.

Meeting!

SCIENCE FOR EVERYDAY USE—Third Edition

by Smith and Vance

BIOLOGY FOR YOU—Third Edition

by Vance and Miller

CHEMISTRY FOR THE NEW AGE—Revised

by Carleton-Carpenter-Woline

PHYSICS FOR THE NEW AGE—Revised

by Carleton-Williams-Buell

*All accompanied by new or revised
laboratory manuals*

J. B. LIPPINCOTT COMPANY

CHICAGO • PHILADELPHIA • ATLANTA • DALLAS • TORONTO

Burnett—Continued from page 67

States? And what can we do as individuals in cooperative attack on these problems? Certain available facts dictated the diagnosis. Logic, at best, is all that I can attempt to draw on, as I tentatively offer suggestions on what to do for your consideration. If anything can be done to improve science teaching it is going to come out of the sharing of ideas and the challenging of ideas that we can engage in through such conferences as this and through the pages of our journal.

What can be done about the fact that large numbers of elementary teachers have little or no formal training in science? Shall we here pass a resolution asking for more science courses for elementary teachers? That would be an empty gesture, and we all know it. Where is there room for more science courses in the already crowded curriculum of the prospective teacher? He needs to be something of an expert in many subject matter fields and, above all, in the guidance and development of children. Shall we add two years to the typical four-year college program? Frankly, I would like to see that done. But we pay elementary teachers less for their investment of time and money in four years of college work than we do many unskilled laborers who have nothing approaching a comparable investment in education. Adding to the training requirement without adding to their salaries would cause the too few teachers now in training for elementary work to bolt the field.

Actually, the best single solution to the problem of inadequately trained elementary teachers (and I imagine that we would be bewailing the lack of training in mathematics if this were a mathematics conference) would be to raise the minimum beginning salaries all over the United States to \$5,000 or so, and then to require training in all the relevant fields commensurate with the importance and the complexity of the job of teaching young children. I am not being facetious about this at all, although I do not expect this solution to the problem to be accepted by the public in the very near future. But I am a little tired of trying to find palliatives to tough professional problems when they are basically the result of inadequately trained personnel and when the solutions are so often financial. Most sincerely, when are the teachers in this country going to organize in an astute but determined and unrelenting demand for decent wages? That is the basic way to get better teachers, better science teaching, and better educated children.

Desirably, the elementary teacher should have at least introductory contacts of some penetration and

breadth with all the basic sciences including geology and astronomy and meteorology, although, I should judge, not of the highly technical sorts sometimes given to young men and women who plan to be elementary teachers rather than technical specialists. However, in a four- or even five-year curriculum this would be highly impracticable as a general rule.

The general education type of fused courses in biological and physical sciences is one way out of the dilemma and a number of colleges have taken it. How satisfactory such courses are for the elementary teacher I don't know. I think that this Association might well undertake to find out as an official project.

Another way out of the dilemma often taken by teachers colleges but rarely by universities, is to offer professionalized general science courses. These vary a good deal over the country as you probably know. How do the results of such offerings compare with those of the fused general education courses? I don't know but I think that we ought to find out.

It is even possible that it would be better for a teacher in training to take but one or two beginning courses—however limited their scope—offered in the conventional sequence of courses for majors in the field. I don't think so, but I wish we knew.

I would like this Association to sponsor a series of studies designed to determine the main and the promising patterns of teacher training in science in the United States and to assess the effectiveness of these several patterns in terms of good teaching in the elementary school. I think that both statistical and case studies are needed here.

What about the elementary teacher already out in the job? What about in-service training and advanced work back to the colleges and universities? What can the NSTA do about the fact that teachers feel inadequate to teach science in the elementary schools for the very good reason that they are inadequate? Well, the NSTA is doing something—a great deal, as a matter of fact. Through journal articles, the *Elementary School Science Bulletin*, special booklets, the packet service, workshops, conferences such as this, and the teacher awards program the Association is creating interest in elementary science, increasing understanding of it, and fostering confidence in elementary teachers who need and are willing to seek for help.

I think that we can find ways to do more, however. I expect that our biggest failure in this in-service work is that we aren't reaching enough teachers, particularly those that need help the most. I am sure that continuing serious attention to this

problem will bear fruit. I have no panaceas to offer but I suggest that as the problems are heavily psychological (the teacher just doesn't want to get involved in something that she thinks will mean more work and about which she feels insecure) our means must be psychologically sound (the teacher will need to see that no one is pressuring her to do the impossible, and find that there are helps to be offered that will make her work more fun and actually easier, through science activities).

I think that high school teachers have much to offer to their colleagues in the elementary school in this respect. We who teach in the high school should not presume to tell elementary teachers how to teach little children—the problems are different. But we could offer our services, humbly but generously, in helping elementary teachers see the fun that is in science, assisting them to locate suitable books for self-education, and helping them to get started at least in understanding the facts, principles, and general phenomena that are pertinent to the work they are trying to do with children.

Nothing is more impressive than a job well done. How can we expect elementary science teachers to even get excited about learning science, let alone teaching it, when most of them have never seen a really top flight science program in action as an integral part of elementary instruction? Maybe we should concentrate our efforts in getting a number of such programs established with such a geographical distribution that other teachers can observe the work being done. Perhaps we could get school boards sufficiently aware of the promise in the idea to pay the tuition and travel expenses of individual teachers who are interested in preparing themselves through summer school work for such experimental and demonstration teaching. These are but a few ideas and they may not be sound. But they illustrate that it is an area worth our thinking about at this conference.

Now, how about the notion that there is no room in the elementary curriculum for science? Believe me, that notion exists in the minds of quite a few teachers and administrators as well. The notion arises, of course, from ignorance as to how science should function in the elementary school program. Apparently some think that science is to be a new

course—to be added to the curriculum like a barnacle.

What can we do to change this notion? Such publications as the NEA Department of Elementary School Principals' *Science For Today's Children*, should be helpful to administrators and teachers alike. Professional books on the teaching of science, and many articles in the professional journals should also be helpful. But more is apparently needed, for this sort of thing has been going on for some time and the erroneous notions are still widely held.

I think that I know why. Have you ever looked at professional books which finally get down to the mat and give details of what science teaching in the elementary school should be like? The philosophy and "point of view" chapters are often full of excellent statements on the place of science in the child's life and, therefore, on what the school program should be like. But when it comes to examples of "here's how you do it," the science either isn't there or it has been wrung through a social studies wringer. It is discouraging.

Have you ever carefully studied resource units designed for the elementary school? It is rare to find one where science activities and concepts have their desirable place. Again, they are so basically social science, for the most part, that all the bases are full and science has struck out—completely out. Now I happen to think that a great number of elementary units of instruction ought to be centered on the life of the child and on such things as community life, transportation, and so forth. But how you can develop units or resource units on such subjects without including a whale of a lot of science is beyond me.

I think that we can do something about this. I can't blame an author who has 64 hours of college social studies, 15 hours of fine and graphic arts, and zero hours of natural sciences for skirting science with occasional gentle pats when he writes a book. But I can blame myself and our collective selves for not making it clear to the publishers that these publications are seriously defective as well as being schizoid—for the philosophy chapters are, as I have said, generally quite kindly disposed to the idea of science in the elementary schools.

I suggest that the NSTA offer the services of pro-

FISK**TEACHERS AGENCY****28 E. Jackson Blvd.****Chicago 4, Ill.**

All educators know of the great demand for teachers. Throughout the year there come into our office exceptional opportunities for teachers, and for all types of positions connected with education. Our service is nation-wide.

professional readers to study professional manuscripts prior to publication and to help the authors give science and the teachers who will read the books the break they deserve. I don't think that this need be done presumptuously. I think that publishers and authors might take kindly to the notion of getting needed help in order to give needed help to the teachers who read them.

In addition, I suggest that the NSTA prepare a few resource units on science topics of typical interest and value to children and make these available to teachers at a reasonable price. I think that such resource units might find a ready market and grow in popularity as teachers find the satisfaction and the heightened interest in learning shown by children who are taught through a well-planned set of science activities.

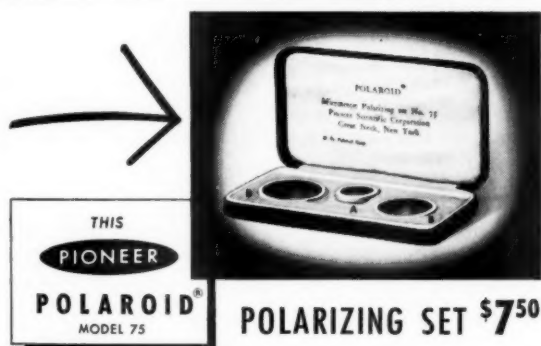
The belief that there are insufficient reference materials in science for children grows, I am sure, from a too narrow preoccupation with graded readers, spellers, and arithmetic books in many school programs. Resource units, and annotated references in professional books for teachers to the excellent trade books that exist should increase teachers' awareness of the existence and possible uses of these materials.

In my opinion, there is a need for one kind of science material which hardly exists at the present time. This is the science-based reading primer—the science equivalent of “Mary Jumps the Rope.” There are some excellent graded science books for the elementary school. But I am talking about reading books for developing reading. If they were made more nearly what children would *want* to read there would be plenty of science doings in them.

How about the lack of time, money, and experience on the part of the teacher to prepare needed equipment? My colleague, Professor Zim, has a point when he suggests that it is asking too much of elementary teachers and their children to construct all the apparatus they need from strings and wires. As Zim is likely to point out, we don't ask the art teacher to mix paints and make crayons and paper.

On the other hand I cannot accept the notion that high school science apparatus is the answer. I'll take the string and wire apparatus any time. High school apparatus, for the most part, just isn't designed to fit the elementary school program. In addition, much of it is much too expensive. What is the answer? I think that the few companies that have produced kits of materials for elementary teachers are on the right track, although the kits I have seen leave much to be desired. But the lack of equipment and ability to make it is a real problem. I strongly urge that the NSTA give consideration to the designing and sponsoring of really top-flight and rugged equipment for elementary school use and that it undertake to get this equipment produced and distributed at a price schools can afford. This doesn't preclude the desirability of teacher made and child made equipment but it would give some much needed help to many thousands of teachers.

Now I have tried to develop none of these ideas to the point of workability. I have rather attempted to suggest some things that might be worth further exploration. In the earlier parts of this paper I explained something of what I conceive to be the proper role of science in the elementary school when I talked of “reading and plugging in” almost in one breath. Professor Gerald Craig has stated: “In all our thinking we must make certain that we are considering how science fits into a program of elementary education in a democracy and not how children fit into a program of science.” Our toughest assignment in working with little children is in fitting content and activities into the real life of the child so that it will have meaning and will result in durable, functioning learnings.



Turns any microscope

into a POLARIZING MICROSCOPE

With this simple, inexpensive set of Polaroid Filters you can quickly convert any standard laboratory microscope (American or European) into an efficient POLARIZING MICROSCOPE.

Analyzer Disc (A) is installed in eyepiece by unscrewing the eye lens assembly, and one of the Polarizer Discs (B) is placed in either the slotted opening under the sub-stage condenser or in the circular depression provided in the swing-out arm.

Ideal for classroom experiments and tests—on slide-mounted specimens of the many materials affected by polarized light. Sold through leading laboratory supply houses.

PIONEER
SCIENTIFIC CORPORATION
Great Neck
New York
® by Polaroid Corp.

For further information
on Polaroid Laboratory
products write for descriptive catalogue
F-621.



STOTLER—continued from page 70

nity is one of the main sources of learning—this is especially true because problems important to the students are at the heart of a modern curriculum. The average student is interested in the here and now, the local and the tangible, as well as the abstract, the far away, and the long ago so typical of the traditional curriculum. In fact, teachers and textbooks can scarcely compete with the community as a source of learning. A carefully chosen expert, whether he visits the classroom or invites a part or all of the class to visit his business or hobby, can provide orientation in a select area which a general source cannot usually equal. Community experts are also useful as advisers concerning those printed materials, such as teaching units, which need to be developed from time to time.

4. Students differ from adults in the degree of their information and skill rather than the kind of approach to their problems. Like adults, their thoughts can be refined toward scientific thinking in any given area explored by scientific procedures under the guidance of a skillful teacher.

The refinement of thought toward scientific thinking in one problem area unfortunately does not mean an important shift towards such thinking in other areas. By starting in the early years, working at problems important to students at each age level, and continuing the process through school, each student can have utilized scientific procedure in every important area—individual and social, present and future.

5. Change comes to be regarded as natural, not evil, as problems are explored. The energy normally applied to the resistance of change is employed in making wise decisions in the face of change.

The study of the problem involves comparison with its history. Most comparisons show progress for man and encouragement for his future. It also shows that those who try to resist change eventually have change thrust upon them by conditions—often involving force and pain. When these factors are recognized there results a greater readiness for voluntary participation in the solution of man's problems.

Skill in democratic procedure also encourages voluntary participation to help solve society's problems. Frustrations are met, but also are expected. They occupy a natural place in the laboratory, a society, and the classroom. Wherever people learn, there will be error and frustration. However, there will also be confidence that laboratory, society, or classroom can succeed by scientific procedure with-

out need for forceful change. After all, it is usually those people who refuse to face their own weaknesses who need scapegoats and force; the scapegoat is unnecessary to well-adjusted people who know their limitations as well as their strength.

6. The person who has observed small children will quickly recognize that the democratic process is not a native characteristic. The person who has tried to teach the democratic process quickly learns that the process is a skill to be learned through actual practice of democratic procedures—that lectures or assigned reading about democracy are relatively ineffective.

The science class offers an unusual opportunity to teach democracy because scientific method, like democratic process, is a skill and best taught through actual practice. In fact, democratic procedure may be considered as a special use of scientific method. Democracy involves constant "on the spot" problem solving by the people of a given social unit. As in scientific method, the problem must be clearly defined by all the people or the solution arrived at by the people will likely be faulty. All the relevant data must be brought to bear on the problem or the solution to the problem will likely be faulty. The possible answers to the problem must be brought to light also. These different possible answers (hypotheses) are often voted upon. One or more is selected for experimentation. If it seems to work, it takes on greater dignity (similar to a theory, etc.). If it doesn't work, another hypothesis is voted a trial.

The propagandist tries to misuse this social use of scientific method by distorting the statement of the problem or by giving forth only select data or hypotheses.

The problem approach shows up the similarity of the scientific and democratic methods, practices them in the classroom, contrasts propaganda and democratic process, and points up methods for detecting propaganda.

RECONDITIONED MICROSCOPES

B & L Model FL-22 @ 80.00

Spencer Model 78 B @ 80.00

like new

Various Accessories

Write us about your needs

Satisfaction or full refund

MONROE MICROSCOPE SERVICE

P. O. Box 656, Rochester 2, N. Y.

7. Problem solving permits the teacher to capitalize upon students' differences. After all, it is not the purpose of democracy to make all people alike or to treat them all alike, but to acknowledge and respect the usefulness of differences and utilize these differences within the group to strengthen the group. For instance, when industrialists are faced with a problem, groups are frequently called in for suggestions. Do they try to bring in a homogeneous group? A group composed of people of the same intelligence, education, beliefs, experience, size, attitude? No. They find that a heterogeneous group working together adds strength to problem solving. So it is in the classroom.

8. In the problem solving curriculum, science is regarded as *organized curiosity*. The teacher begins with *curiosity* rather than *organization*, for curiosity is often killed if the teacher tries to transfer her knowledge directly to the student. The logic of the learning student deserves and gets a place of honor over the logic of the learned student (the teacher) in a problem solving class. However, as the learning student explores problems important to him, knowledge is pieced together and logical fields of learning such as geography, physics, and chemistry gradually emerge (plus increased curiosity and greater skill in using the scientific procedures to satisfy this curiosity with a minimum of error).

For instance, a problem such as "How could more things be produced?" might be originated in a class. The study of the background of the problem would provide some knowledge of history and in an important context. A study of natural resources would involve some study of geography and geology. Chemistry might be learned through study of some of our present production processes. The machinery of production involves physics. The study of a problem cannot be separated into isolated fields, but a study of enough problems could provide a readiness plus the background for an organization into these fields later.

9. Clearly no text can be written for a democratic curriculum. A wide variety of learning devices are necessary—movies, filmstrips, charts, pictures, models, magazines, papers, books (on all subjects and at a variety of reading levels), speeches, field trips, many others. Some of the materials will favor one answer to a given problem, some another. Some will be fact, some propaganda. Some will be modern, some obsolete. This will make the study of the problem in the classroom more difficult, but it is like life in a democracy, and will help the student to become a more discriminating and more discerning citizen of our democracy.

In fact the typical text, containing as it does a whole course, can scarcely compete in the free market of a problem solving classroom with the smaller unit-type booklet. A text contains the equivalent of several booklets, but only one person can use it at a time. Booklets are a more attractive size for reading. They can be at several reading levels. They do not determine a sequence but can be used in any problem solving curriculum; science discoveries occur frequently; a booklet is specific and can be modified, but one section of a text must await the revision of the whole text. Also a booklet can be more controversial than a text, for if one booklet is banned the other booklets can still be sold. If a part of a text is banned the whole book is not sold—hence the tendency to avoid theory and controversy. However, there is a need for a set of booklets, each of which opens a problem area. Most books tend to terminate the study of the problem, through the "spoon-feeding" data, experiments, and answers.

10. The problem solving class may have home work but the emphasis is upon a literal interpretation of the word home. There are already too many distractions on the scene that tend to fracture the home life of Americans. An assignment that requires the isolation of the student from the family for learning does not fortify the home. Assignments that utilize experiments with home equipment, the development of hobbies, exhibits for science fairs, or discussions on controversies of the day are just as much home work as the traditional concept, and it can involve the whole family.

As mentioned at the beginning of this paper the ideas herein are largely speculative. However, phases of most of the ideas are being tried in schools throughout the nation. In Portland Public Schools we are slowly experimenting with and implementing the ideas here outlined. We have charted a series of problems for general science, biology, and physical science—some philosophical, some crusading, some of the immediate type, and some mixtures of these problems. About half of these problems have been expanded into resource units. These units were checked by experts from the community before they went to press. The other problems are also being developed. We are moving into the use of varied resources—including a variety of books and the utilization of resource people and field trips. Our classrooms are being remodeled as fast as finances will permit and we are trying to make them flexible enough to entertain any trend without the necessity of carpentry. We feel that science teachers must not only teach science, they must practice it in their teaching.

Book Reviews

ALL ABOUT THE WEATHER. Ivan Ray Tannehill. Illustrated by Rene Martin. 148 pp. Random House. New York. 1953.

This book was written by an expert on the weather who can and does explain it so that any of us can understand it. The elementary school child as well as the busy adult who needs information about the weather will profit from reading Mr. Tannehill's book.

This reviewer likes the emphasis on ways of getting information about the weather and on the fact that we change our interpretations as we continue to get new information. Illustrations are well planned and executed. They fit as an integral part into the context of the written material. This book does make and will continue over a long period of time to make a valuable contribution to the understanding of teachers and children.

The biologist may well criticize the idea, page 14, that carbon dioxide serves the same purpose for plants that oxygen does for animals.

JULIAN GREENLEE
Florida State University
Tallahassee, Florida

FLIGHT TODAY AND TOMORROW. Margaret O. Hyde. 140 pp. \$2.50. Whittlesey House. McGraw-Hill Book Company, Inc. New York. 1953.

Children today are vitally interested in flight and here is a book which captures that interest and plays upon the imagination while giving the child scientific information and understandings.

The book tells of modern airplanes, their kinds, parts and why they fly. It takes the reader on a flight in a small plane and explains how it is maneuvered. It examines instruments and makes use of navigational facilities on a cross country "blind" flight. It explains jet and rocket propulsion. Some important understandings for everyone are developed in the chapter considering the effect of air transportation on the individual and society, and the role of aviation in defense. Probably most children will like best the description of space travel with which the book concludes. Although many of the ideas here (for example, the zero-gravity con-

dition) tax the imagination, they represent the best scientific thinking and planning of today. Among the most valuable features of the book are the numerous diagrams and illustrations by Clifford Geary.

It is unfortunate, but in the opinion of this reviewer, some small errors and a few rather serious ones appear in the text. For example, on page 29 the statement is made that, "Thrust must be greater than drag and lift must be greater than gravity if a plane is to fly forward in the air." However according to Newton's First Law of Motion, opposite forces are equal under steady flight conditions. In flying the small plane, on pages 34 and 37, the pilot should unbank the plane with opposite aileron rather than by simply returning the wheel to neutral, and as indicated on pages 37 and 38, he could hardly accomplish a true spin with the control column forward. Isn't it difficult to achieve simplicity, readability and accuracy all at once? Yet the unqualified statement on page 28 that "Heavier planes need more speed than light planes" may generate the idea that only one factor affects lift. Sometimes, too, good descriptive writing as that describing a jet airliner "swooping" down for a landing is a little too breathless for real perception.

The strongest features of the book seem to be the presentation of the social effects of flight and the stimulation to thinking of the examples of problems connected with space travel. There is a place for "Flight Today and Tomorrow" in a child's library and youngsters with scientific aptitude will love it.

JEAN MCGREGOR
McKinley High School
Washington, D. C.

REPTILES AND AMPHIBIANS—A GUIDE TO FAMILIAR AMERICAN SPECIES. Herbert S. Zim and Hobart M. Smith. 157 pp. \$1.00 Simon and Schuster, Inc. New York, 1953.

Dr. Zim, assisted by the president of The Herpetologist's League and artist James Irving, has produced another paper bound pocket guide invaluable to general science, biology, and elementary teachers.

Sixth in the Golden Nature Guide series, *Reptiles and Amphibians* uses two hundred and twelve full

color illustrations to describe those species with which the average person is most likely to come into contact.

The text is brief with most of the information being provided by the excellent illustrations. This feature makes the book particularly satisfying to the student just learning to use books for identification and also permits rapid identification by those more experienced. Unfortunately, no binomial nomenclature is included which is necessary in resolving questionable identities due to conflicting common names.

The authors offer advice on snake bite treatment and on the collection and preservation of specimens. They explain how to use the book and how it is separated into classes, orders, and species. Each of these sections is preceded by a general description of the class or order as a whole.

Interesting and informative, this book will soon pay for itself with usefulness and enjoyment.

WARD R. REISS
Johnsville-New Lebanon School
New Lebanon, Ohio

FIDDLER CRAB. Mary Adrian. Illustrated by Jean Martinez. 44 pp. \$2.00. Holiday House, New York. 1953.

What is more fascinating than a visit to the seashore? Among the myriad forms of shells and sealife which attract our attention, the Fiddler Crab is almost sure to be seen, with his one big "fiddle" claw raised like a shield, scurrying to his burrow at your approach. However, beyond our sight in the little known depths of the sea occurs the real life adventure of the Fiddler Crab. Emphasizing the ocean larval stage the author opens to young readers the strange and intriguing water world. To enable the intermediate level child to understand the material without aid, the Fiddler Crab is individualized but not humanized.

The illustrations, without which an elementary child cannot fully comprehend scientific material, are excellently prepared. This small, valuable life cycle study was enthusiastically received by my pupils.

JAMES SHORT
Immokalee Elementary School
Immokalee, Florida

PARAKEETS. Herbert S. Zim. Illustrated by Larry Kettelkamp. 64 pp. \$2.00. William Morrow and Company. New York. 1953.

Anyone who possesses a bit of curiosity about living things may want to start keeping parakeets as pets after reading this informative and interesting book about them. Something is told about the origin, kinds, and relatives of parakeets; about how to provide suitable cages for them, and about how to feed and care for them. More interesting than all of this are the specific suggestions for training them together with the illustrations which suggest what a parakeet may be expected to learn to do. Also included is sufficient information concerning the breeding and rearing of parakeets to make the reader think he can do it. I am convinced by this book that parakeets may make ideal pets for an elementary or biology classroom as well as for the home.

N. E. BINGHAM
University of Florida
Gainesville, Florida

ALL ABOUT THE SEA. Ferdinand C. Lane. 148 pp. Random House. New York, 1953.

This is a story of the seas from the beginning of our earth to the present time. The author explains how the earth was formed and how the seas and continents were developed. He describes the mountains at the bottom of the sea and also the currents of the oceans. Mr. Lane goes on to discuss the development of life in the sea. He includes in this discussion the various types of plant and animal life found there. He also points out how the sea affects our climate and how man is dependent upon the sea.

The author writes in a very simple, fluent style. He uses very little technical language. What scientific terms are used in the text are fully defined. All of the illustrations, except those on the dust jacket, are line drawings. It would be better to have fewer illustrations in color. A glossary or a pronunciation guide is needed to help the reader pronounce such words as globigerina, pteropods, radiolarians, etc. The vocabulary and style of this book is such that it is suited for junior high school students and slower high school pupils.

IRVING D. KIRK
Furness Junior High School
Philadelphia, Pa.



These coupons announce the availability of free and low-cost teaching aids for science. Business-sponsored items have been reviewed by the NSTA Evaluation Committee and approved for distribution by the Association. To procure copies of desired items, fill out and clip the corresponding coupons and mail these, together with any remittance required, to the NSTA Executive Secretary, 1201 Sixteenth Street, N.W., Washington 6. Watch these columns for additional offerings in future issues of *The Science Teacher*. (Print or type coupons.)

FILM AND TEXTBOOK CORRELATIONS FOR ELEMENTARY SCHOOL SCIENCE. *Young America Films, Inc.* Describes the YAF basic program of teaching films for elementary school science. Page-by-page correlation with the textbook series of seven different publishers. Lists films and filmstrips that are available. For teacher use. 12 pp.; free.

BATTELLE. *Battelle Memorial Institute.* Beautifully illustrated brochure providing a "tour" of this modern scientific research institution. Helps the reader to understand what research is like and how researchers do their work. Single copies only; free.

Please send me.....free copies of **Film and Textbook Correlation for Elementary School Science.**

Name.....
School.....
Address.....
Post Office.....Zone.....State.....

Please send me one free copy of **Battelle.**

Name.....
School.....
Address.....
Post Office.....Zone.....State.....

READERS' COLUMN—continued from page 52

he may have to be reminded that "It's all done so that the college may render its maximum service." However persistent the departing one may be he'll not get any objective, universally-agreed-on ratings on his limited eyesight, poor hearing, over-wordy class-room conduct, or chronic mannerisms that compromise his acceptability by his students.

What to do? Educators pride themselves upon their improvement of means of assessing their students' progress toward desired aims. By such means they have tailored the program to the individual student. If that sort of service is possible for an eighteen-year-old, why not for a three-score-five? Intelligent concern could lead to an analysis to determine those respects in which an older teacher is defective in his various faculty services. That done, a plan and an instrument for identifying those defects could be devised and standardized. With such facilities available the retirement program could be formulated in terms of *personality specifics* rather than the present very general practice of using chronological age and personal opinion of administrators. The validity of the age criterion is questionable and the objectivity of the committee opinion is suspect. Why doesn't some Teachers' College candidate for the second graduate degree move into this open field?

B C H

Professor Emeritus

Our Advertisers

	Page
Albert Teachers Agency	75
American Optical Company.....	49
Battelle Memorial Institute.....	Clip'n Mail
Bausch & Lomb Optical Company.....	54
Bell Telephone Laboratories.....	50
Central Scientific Company.....	Cover IV
Corning Glass Works.....	Cover III
Denoyer-Geppert Company.....	92
Fisk Teachers Agency.....	98
The Graf-Apsco Company.....	94
Harcourt, Brace and Company.....	92
D. C. Heath and Company.....	51
Iroquois Publishing Company, Inc.....	85
J. B. Lippincott Company.....	96
Monroe Microscope Service.....	100
Testa Manufacturing Company.....	73
Pioneer Scientific Corporation.....	99
E. H. Sheldon Equipment Company.....	Cover II
Universal Scientific Company.....	82
D. Van Nostrand Company, Inc.....	80
W. M. Welch Scientific Company.....	56
Young America Films, Inc.....	Clip'n Mail

so that
How-
not get
is lim-
n con-
his ac-

n their
prog-
y have
If that
d, why
could
which
y serv-
entify-
rdized.
rogram
pecifics
f using
ministra-
ionable
is sus-
ndidate
s open

ritus

Page
75
49
n Mail
54
50
over IV
over III
92
98
94
92
51
85
96
100
73
99
over II
82
80
56
n Mail

ACHER



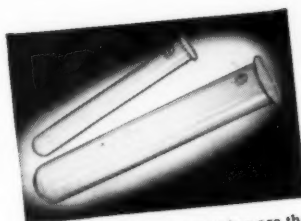
Laboratory Glassware for STRENGTH



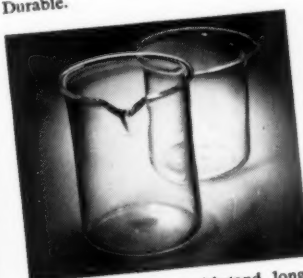
Three Neck Flasks—Made from selected blanks of substantial weight with carefully sealed side necks for greatest strength. All necks tooled for uniform stopper fit.



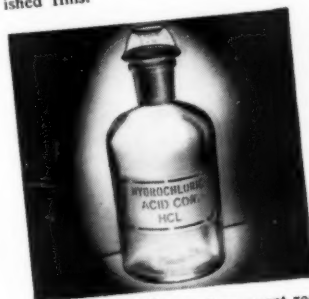
Funnels—Flutes, plain, long stem, short stem or stemless—small or large diameter. All built for heavy-duty wear. Edges beaded for easier cleaning, greater safety.



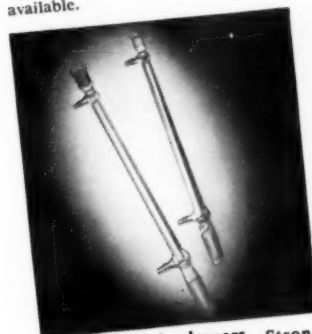
Test Tubes—PYREX test tubes are the most economical available. High in thermal and physical strength and chemically stable. Never cloud. Durable.



Beakers—Built to withstand long, hard use. Supplied in sizes, weights and designs suitable for all general laboratory work. All with fire polished rims.



Reagent Bottles—Permanent red glass labels. Interchangeable stoppers. High chemical stability protects standard solution. Special labels available.



PYREX West Condensers—Strong. Efficient. Glass permits thin inner wall for high heat transfer. Protected by heavy outer jacket.

What this added strength means to you . . .

The biggest factor in laboratory glassware costs is breakage, either from mechanical or thermal shock. The best way to minimize breakage is to standardize on PYREX laboratory glassware.

The properties of PYREX brand glass 7740 are balanced to give you extra mechanical and thermal strength. Its low expansion coefficient permits heavier construction without sacrificing necessary thermal shock resistance.

Wherever possible, extra strength is designed into every piece of PYREX ware. Reinforced joints at tubulation, pressed construction when possible and uniform wall thicknesses are only a few examples of this *built-in* strength.

But strength is only one of the added benefits you get with PYREX ware. Its chemical durability provides protection against corrosive chemicals and insures against contamination of sensitive reagents.

The products you see illustrated, and hundreds more, are carried in stock by your laboratory supply dealer—call him today for anything you need . . . he is always ready to be helpful.



CORNING GLASS WORKS CORNING, N. Y.

Corning means research in Glass



Highest Quality
Fine Definition
Extreme Sharpness

THE NEW YORK STATE LIBRARY
ALBANY 1 N Y
ST-LSNEA-10/1/50

This is
just one of
more than
20,000 items
carried in
stock

CENCO REPLICA GRAT

developed and manufactured by Cenco

Made after the process developed by Dr. R. James Wallace . . . faithful replicas of Rowland, Michelson and Carnegie Institute originals. Carefully selected for quality and tested on a precision spectrometer for definition and sharpness.

Casts are in the form of especially processed collodian films. Mounted on best optical glass for the transmission gratings, and upon aluminized surfaces for both plane reflection and concave reflection gratings.

With 14 branch offices
and warehouses, Cenco
provides prompt service
and shipment.

Catalog Number	Size of Ruled Surface, mm	Lines per Inch in Original	Grade A Each	Grade B Each
86710	20 x 25	7500	\$11.25	\$7.00
86720	20 x 25	10000	11.25	7.00
86735	20 x 25	15000	11.25	7.00
86745	20 x 25	25000	11.25	7.00

Write for circular No. 1220

CENCO
.....

The most complete line of
scientific instruments and labo-
ratory supplies in the world



CENTRAL SCIENTIFIC COMPANY
1700 IRVING PARK ROAD • CHICAGO 13, ILLINOIS
CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO
SANTA CLARA LOS ANGELES TORONTO MONTREAL VANCOUVER OTTAWA

REFINERY SUPPLY COMPANY
624 EAST FOURTH STREET • TULSA 3, OKLAHOMA